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The development, validation, and application of a computer anxiety instrument

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THE DEVELOPMENT, VALIDATION, AND APPLICATION OF A COMPUTER ANXIETY INSTRUMENT

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The development, validation, and application

of a computer anxiety instrument

by

Li-Zung Lin

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CHAPTER I INTRODUCTION

With the rapid growth of science and technology, a high-technological era is approaching. Products of high-technology, e.g., the electronic word processor, personal computer, microwave oven, video cassette recorder, stereo, telephone answering machine, bank automatic teller, and food processor have become an unavoidable part of everyday life. Among those new devices, the computer is a typical one.

The computer, a preeminent technological invention of this century, has further accelerated the development of modern technology. Its applications and potentialities are so impressive that nearly everything is affected by computers. The development of computers is so rapid that even before we get comfortable with a new innovation, there is another new model on the market. People are at first somewhat excited with new technological developments; however, they soon become concerned that they may not be able to cope with all of these new advances. Some people do enjoy and appreciate what technology does to improve human living, but many others become fearful, nervous, neglectful, or resistant to these new developments.

Booth (1982) explained, "...the anxious responses toward technology are a combination of concerns--the age-old distrust of any newfangled invention; the fear of losing your job, or having it changed for the worse; and the worry that high-tech hardware will irrevocably harm our society, our environment and our lives." Wolfe (1984) indicated that "What most frightens many of us about new technology is probably the prospect of changing our habits and learning new skills to adapt."

Turkle (1982), after surveying hundreds of personal computer users about their relationship with their machines, said that "...the fact that the computer touches the sphere of intelligence, which people have long thought to be uniquely theirs, is the main reason why people are so scared of the computer". Raub (1983) explained the arousal of computer anxiety by suggesting that "Most people have not been prepared for such a rapid penetration of technology. Their understanding of computers has not kept pace with the technology, and this inability to rapidly assimilate the technology has resulted in computer anxiety."

It is a fact that although computers play an essential part in human life, more and more people have found themselves avoiding, being fearful of, nervous or anxious about computers. Raub (1981) proposed that misconceptions of computers aroused the anxiety toward computers. He investigated college students' attitudes toward computers, and found that gender, computer experience, college major, math anxiety and trait anxiety were five significant factors to computer anxiety. Hands-on computer program developing experience reduced the computer usage anxiety, but did not improve students' appreciation of computer technology. He finally concluded that computer attitudes are gender-specific and culturally-learned. Computer anxiety comprised a heterogeneous set of fears which evolved along an assimilation/accommodation continuum. In his research, owing to the restricted range of ages in college students, no linear relationship emerged between age and computer anxiety.

After Raub's study, numerous articles have discussed the phenomena of fears, phobia or anxiety of computers, but few have put an effort into understanding the nature and conditions of computer anxiety. It is a belief that research contributing to a deeper understanding of computer anxiety will be useful in the design of programs for both its treatments and prevention and, furthermore, is necessary for the establishment of computer anxiety as an important explanatory construct, linked to other anxiety or major psychological variables. For example, studies about actual prevalence and intensity of computer anxiety in various sub-populations of individuals will aid in identifying groups or types of people particularly in need of treatment. Information concerning background and experiential factors related to the occurrence of computer anxiety will aid in explaining its genesis and, additionally, provide suggestions for its prevention. Research on correlations of computer anxiety is necessary to determine the extent to which computer anxiety tends to occur as part of a constellation of other anxieties and traits or is, rather, independent from others. Finally, further information is needed concerning the effects of computer anxiety on computer avoidance, on performance in computer courses, and on decision-making of educational or career plans. However, in order to be successful in understanding the nature or influences of computer anxiety, a valid and reliable instrument is essential. The primary purpose of this study was to develop and validate a computer anxiety instrument for further uses; the phenomena and impacts of computer anxiety were also examined simultaneously.

Statement of the Problem

This study was designed to develop an instrument to measure the anxiety toward computers in general and to identify the major aspects which affect the inducement of computer anxiety.

Purposes of the Study

The purposes of this study, along with the development of a valid computer anxiety measurement, were to understand the nature and the occurrence of computer anxiety, in order to help individuals to avoid or overcome the anxiety toward computers and feel more comfortable in today's computerized environment.

More specifically, the purposes of this study were as follows:

1. to develop and validate a paper-pencil, self-report type of instrument for measuring the anxiety and relative attitude toward computers;
2. to determine the main aspects which suggested a framework to build a model structure of computer anxiety;
3. to investigate variables which potentially contribute to the anxiety toward computers; and
4. provide industries, educators, and individuals with information for computer anxiety prevention and treatment.

Research Questions

Three computer anxiety related features were examined in this study:

1. Was the theoretical model used in developing the computer anxiety instrument in this study appropriate? Were those items which were included in the instrument clearly stated and were those items able to discriminate between the potentially low anxious and high anxious persons? Was the instrument developed in the study valid and reliable?
2. What were the major factors which contribute to the variance of anxiety toward computers? Could these factors be improved and manipulated? Were most of these factors an individual's traits or situational transitory factors in nature?
3. Were particular types or groups of individuals prone to have higher computer anxiety? Who were these types or groups of individuals?

Hypotheses

1. A unidimensional design with four subdomains which correlate with one another provide a satisfactory instrument development model for measuring the anxiety toward computers.
2. The measured level of a person's computer anxiety is related to age, gender, educational level, computer courses taken, computer

experiences, ownership of a personal computer, attitude toward math, math grades, parent attitude and occupation, general anxiety, and computer learning environment in school.

3. The major factors which elicit the computer anxiety of a male are different from those factors of a female.
4. The major factors which elicit the computer anxiety of high school students are different from the factors of the other groups which are composed of community college students, college students, and graduate students.
5. There are people with special characteristics who are prone to have higher computer anxiety than others.

Procedure of the Study

The major procedure of this study included following steps:

1. To synthesize, by reviewing previous anxiety research, an applicable anxiety theory for computer anxiety.
2. To define the term "computer anxiety".
3. To determine the population of the study.
4. To select the sample from the population.
5. To determine a theoretical model of computer anxiety from referencing existing anxiety instruments--general anxiety, trait-anxiety, state-anxiety, math-anxiety, and others.

6. To develop a computer anxiety instrument based on the theoretical model which is determined from procedure 5.
7. To verify the content validity, and the appropriateness of the construction of the tentative instrument.
8. To revise the instrument based on the recommendations from procedure 7.
9. To determine the scale value of each item.
10. To conduct a pilot study with people selected from the population to try out the instrument.
11. To conduct an item analysis of the instrument based on the pilot study data.
12. To finally revise the instrument from the results of the pilot study and item analysis.
13. To conduct a field test and further validate the instrument.
14. To analyze the data and test the hypotheses:
    (1) a factor analysis was employed to determine the dimension(s) of the computer anxiety instrument;
    (2) a descriptive analysis was used to determine the major reasons for not learning or using computers;
    (3) an analysis of variance and multiple-regression analysis were applied to investigate the factors which correspond to the differences in computer anxiety among different subgroups.
15. To finish the research report based on the results of data analysis.

Assumptions of the Study

For the purposes of the study, the following assumptions were made:

1. Computer anxiety is identifiable and measurable.
2. Computer anxiety is a psychological continuum, the scale value of computer anxiety distributes from negative infinity to positive infinity.
3. Computer anxiety is reducible and removable. That is, training or curricula changes will cause an individual to feel more comfortable while re-encountering the computer, and such treatments will affect the entire process of computer anxiety arousal.
4. The scale values applied in this study are appropriate and valid.
5. The measurement of computer anxiety, which indicates the individuals' anxiety level, is representative of how much anxiety the respondents have toward the computer.
6. Subjects who responded to the instrument perceived the meaning of each item identically and answered the items based on their true feelings toward computers.

Limitations of the Study

This study was conducted under the following limitations:

1. The measurement of computer anxiety was limited to a self-report method.

2. The pilot study was limited to include only undergraduate students at Iowa State University.
3. Samples were limited to students. Persons in other occupations were not included.
4. Samples were not representative of the total population of individuals over 12 years old. A random sampling procedure was not applied in selecting the samples. Samples of convenience (volunteers) were used.
5. The responses to computer anxiety probably would be contaminated by social expectation and/or sex-role stereotypes.

Definition of Terms

Anxiety

An unpleasant emotional state or condition which is characterized by subjective feelings of tension, apprehension, and worry, and by activation or arousal of the autonomic nervous system, and accompanied by physiological, phenomenological, and behavioral manifestations.

Trait anxiety

A relatively stable individual difference in anxiety proneness as a personality trait. Trait anxiety is not manifested directly in behavior, rather it is inferred from the frequency and intensity of the individual's elevations in state anxiety over time.

State anxiety

A transitory emotional state or condition of the human organism that varies in intensity and fluctuates over time. State anxiety is evoked whenever an individual perceives a particular stimulus or situation as potentially harmful, dangerous, or self-threatening; otherwise, the level of state anxiety is low.

Trait-state anxiety theory

The Trait-State Anxiety Theory begins with the conceptual distinction between anxiety as a transitory state and as a relatively stable personality trait. Persons high in trait anxiety tend to perceive a greater number of situations as more dangerous or threatening than persons who are low in trait anxiety, and respond to threatening situations with state anxiety elevations of greater intensity. The nature or type of stress associated with a situation is also important in determining the likelihood that high trait anxiety individuals will respond with higher elevations in state anxiety. Differences shown in performance on learning tasks or mental conditions involve some form of psychological stress, such as direct or implied threats to self-esteem, ego-involving instructions, or failure feedback. In contrast, persons with high trait anxiety do not perceive physical dangers such as pain or the threat of pain as any more threatening than low trait anxiety persons.

Anxiety-as-process

The Anxiety-as-Process concept indicates that the result of anxiety is a sequence of cognitive, affective, and behavioral responses that occur as a reaction to some form of stress. Cognitive appraisals of danger are immediately followed by an anxiety state reaction, or by increments in levels of state anxiety intensity. The unpleasant experience of anxiety will engage an individual to reappraise the stressful circumstances and then help to identify appropriate behavior to cope or avoid the stress.

Computer anxiety

Computer anxiety in this study applies the anxiety-as-process concept, and is defined as a continuously perceptive or interpretative process of computers which results in a negative attitude or behavior toward computers. While individuals encounter computers under any number of circumstances (developing computer programs, applying commercial computer packages, playing computer games or other computer involved situations), the individual, according to previous experiences or personal characteristic tendencies interprets computers as dangerous or threatening subjects. The dangerous or threatening interpretation results in anxious reactions toward computers. Those reactions may include a fearful, scared, nervous, or uneasy emotional change in phenomenology; rapid heart beat, perspiration, dryness of mouth, change in voice quality, trembling, increase of systolic blood pressure, and speed of breathing in physiology; and resistance, reluctance or avoidance to touch, talk or even think about computers in performance.

On the whole, the inducement of computer anxiety appears like the closed loop diagrammed in Figure 1 which was derived from Spielberger's anxiety-as-process concept.

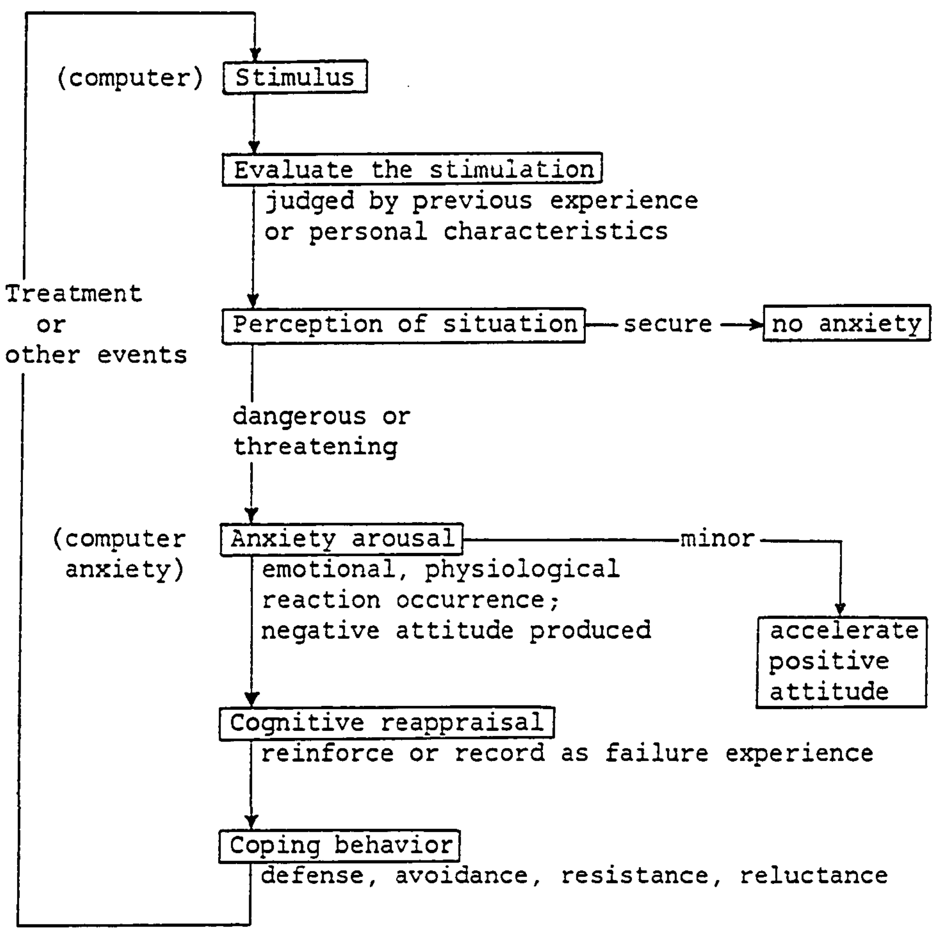

FIGURE 1. Anxiety-as-Process Loop

The process begins with an encounter with a computer (stimulus) and moves to the arousal of computer anxiety (anxiety arousal) which results in the resistance and avoidance and fear of using computers (coping behavior). It is assumed in this loop that the intensity of computer anxiety will be reduced or altered once the dangerous or threatening factors have been removed or modified. This means that by applying a carefully designed treatment, the computer anxiety is possibly removed. Finally, the re-encounter with a computer (stimulus) will cause the repetition of the process and change the degree of anxiety according to the special treatment and/or other events which occur between the two encounters.

CHAPTER II REVIEW OF LITERATURE

In this review, articles which pertain to the research topic have been examined and presented in two areas: (1) Anxiety, and (2) Computers and Education. In the first area, the historical development of anxiety studies, anxiety theory, definitions and measurements of anxiety, and interactions and effects of anxiety are discussed. The second area is concerned with what computers can do for education. The importance of computers to education; computer-supported learning taxonomy; computers' current uses in schools; the potential, limitations, and problems of computer implementation; and the possible future development and applications of computers in education are included.

Anxiety

History of anxiety

Anxiety is one of the central constructs in psychobiology. It plays a crucial role in psychology, learning theory, psychopathology and many other fields. Since 1950, more than 5,000 articles and books have been published on this topic. Recently, due to the advanced development of science and technology, a more stressful and complex environment has been encountered by human beings, therefore, stress and anxiety have become a popular topic and attract increasing attention from behavioral and medical scientists.

Although for over the past three decades, psychologists, psychotherapists, and phenomenalists have tried to understand the nature and conditions of anxiety, they are on the whole, in a controversial stage. One reason why such research has been equivocal is probably due to the ambiguity of the term "anxiety". Cattell and Scheier (1961) initially formulated the conceptual analysis of anxiety. They found that the term "anxiety" had been used to refer not only to a transitory state of an organism, but also to a relatively stable personality trait. Since then, the Trait-State Anxiety Theory (Spielberger, 1972a) began with a conceptual distinction between anxiety as a transitory state (State Anxiety, A-state), and anxiety as a relatively stable individual trait (Trait Anxiety, A-trait).

Consistent with this view, both Zuckerman (1971) and Spielberger (1972a) have found some evidence indicating that A-trait has some predictive values for A-state measure during conditions of certain types of stress, such as examinations, but has poor predictive value for A-state under other given situations. Zuckerman, from the viewpoint of measurement, interpreted the relationship between trait and state anxiety as follows: While both trait and state tests should have high internal consistency, or item reliability, trait tests should also have high retest reliability, while state tests should have low retest reliability. It was assumed that states fluctuate over time not because of errors of measurement but as a function of external events affecting the individual.

More recently, Spielberger (1972a) proposed the "anxiety-as-process" concept. The concept of anxiety-as-process usually implied a sequence of events from evaluating and perceiving the situations; to arousing anxiety-state; reappraising cognitively; and producing the coping, defensive or avoidance behaviors. The empirical work of Lazarus and Averill (1972) also implied anxiety as a complex process that involves stress, cognitive appraisals of threat, and the absence of behavioral mechanisms that enable the individual to cope effectively with the stress. The end result of this process is an emotional reaction in which cognitive elements predominate.

Anxiety, considered as a complex emotional reaction then, is evoked in an individual who interprets a specific situation as dangerous or threatening. In other words, the elevation of anxiety is more subjective than objective. An objectively dangerous or stressful situation may not be necessarily agreed upon by all individuals. After realizing the complexity of anxiety in nature, scholars like Spielberger (1972b) and McReynolds (1972) proposed to focus on studying anxiety in a specific stress situation (e.g., test anxiety, math anxiety, teaching anxiety, and others.) in order to better understand and clarify the insights and its causal relationship to anxiety in a particular area in which one is most prone to anxiety and the effects on his/her behavior.

Since the 1970s many anxiety studies have devoted attention to measurement in the specific anxiety areas. For example, math anxiety, test anxiety, social anxiety, teacher anxiety, speech anxiety, death anxiety, counselor anxiety, science anxiety, writing anxiety, communication anxiety, and sexual anxiety have been studied. In these studies, the questions of "why and how is the anxiety aroused", "what is the relationship between anxiety and learning, achievement or behavior" and "how is anxiety managed" are frequently examined.

Trait-state anxiety theory

State anxiety (A-state) may be conceptualized as a transitory emotional state or condition of the human organism that varies in intensity and fluctuates over time. A-states are characterized by subjective, consciously perceived feelings of tension and apprehension, and activation of the autonomic nervous system. The level of A-state is high in circumstances that are perceived by an individual to be threatening, irrespective of the objective danger; A-state intensity is relatively low in nonstressful situations, or in circumstances in which an existing danger is not perceived as threatening.

Trait anxiety (A-trait) refers to relatively stable individual differences in anxiety proneness. That is, to differences in the disposition to perceive a wide range of stimulus situations as dangerous or threatening; and in the tendency to respond to such threats with A-state reactions. A-trait may also be regarded as reflecting individual differences in the adequacy and the intensity with which A-states have been manifested in the past, and in the probability that such states will be experienced in the future. Persons who are high in A-trait, such as psychoneurotic patients, tend to perceive a larger number of situations as dangerous or threatening than do people who are low in A-trait. They also respond to threatening situations with A-state elevations of greater intensity.

In general, the experimental literature on anxiety is consistent with the hypothesis that situations which pose direct or implied threats to self-esteem produce differential levels of A-state in persons who differ in A-trait.

A schematic diagram of Trait-State Anxiety Theory is presented in Figure 2. It provides a cross-sectional analysis of anxiety phenomena. The theory assumes that the arousal of anxiety states involves a process or sequence of temporally-ordered events initiated by either external or internal stimuli that are perceived to be dangerous or threatening by an individual. Any internal stimulus which causes an individual to think about or anticipate as a dangerous or frightening situation may also evoke high levels of A-state. However, the appraisal of a particular stimulus or situation as threatening is also influenced by a person's aptitude, abilities, and past experience, as well as his/her level of A-trait and the objective danger that is inherent in the situation.

Once a stimulus situation is appraised as threatening it is assumed that: (1) an A-state reaction will be evoked, and (2) the intensity of this reaction will be proportional to the amount of threat the situation poses for the individual. It is further assumed that the duration of the A-state reaction will depend upon the persistence of the evoking stimuli and the individual's previous experience in dealing with similar

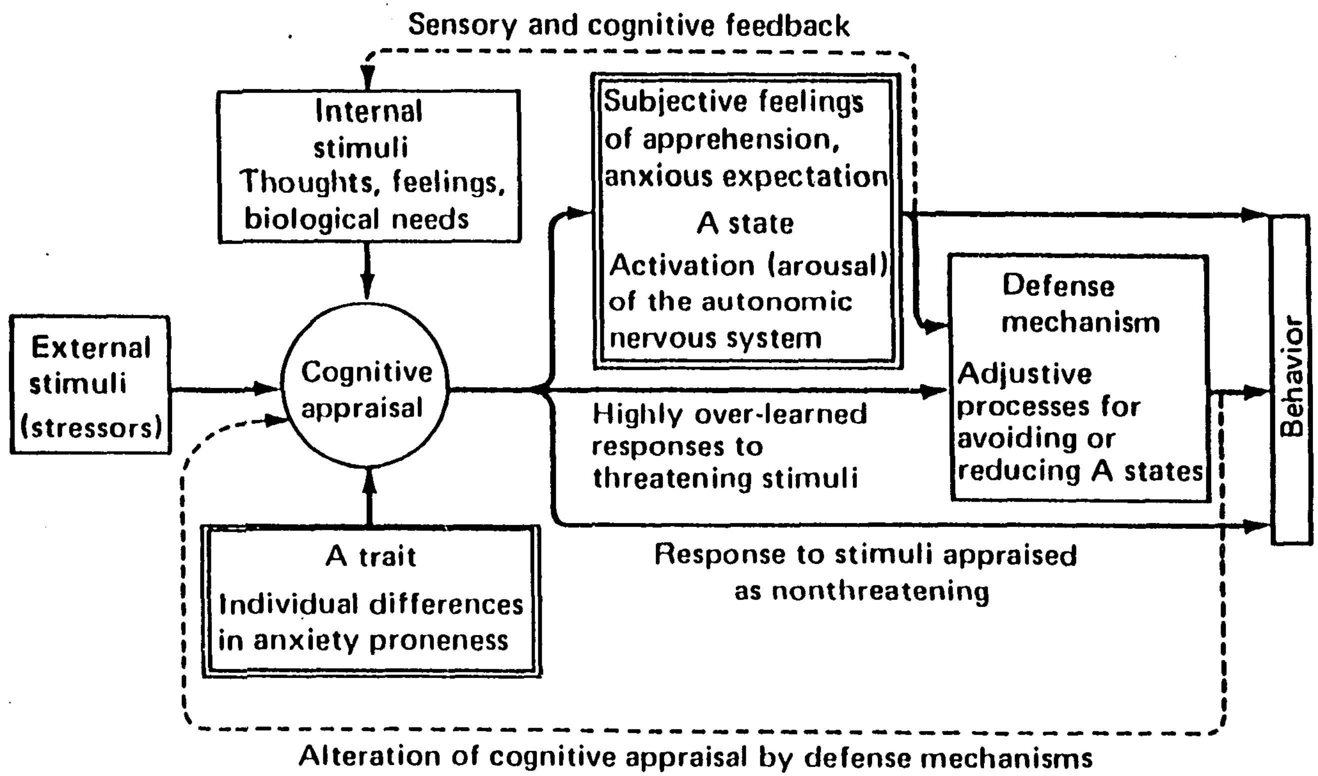

FIGURE 2. Trait-State Anxiety Theory

From Anxiety and Behavior, edited by C. D. Spielberger, New York, Academic Press, 1966.

circumstances. Stressful situations that are encountered frequently may lead an individual to develop effective coping responses that quickly alleviate or minimize the danger and thereby immediately reduce the level of A-state intensity. A person may also respond to threatening situations with defensive processes that serve to reduce the intensity of A-state reactions.

High levels of A-state intensity are experienced as unpleasant and may serve to initiate cognitive or motoric processes that have effectively reduced A-states in the past.

It was noted previously that two important classes of stressor situations can be identified that appear to have different implications for the evocation of A-state in persons who differ in A-trait: (1) individuals with high A-trait appear to interpret circumstances in which their personal adequacy is evaluated as more threatening than do low A-trait individuals, and (2) situations that are characterized by physical danger are not interpreted as differentially threatening by high and low A-trait subjects.

In summary, the schematic representation of the Trait-State Anxiety Theory (Figure 2) posits two different anxiety constructs, A-state and A-trait, and distinguished these two constructs from the stimulus conditions which evoke A-state reactions and the defenses that help individuals to avoid or reduce A-state. The diagram also provides a conceptual frame of reference for classifying the major variables that should be considered in research on anxiety phenomena, and suggests some of the possible inter-relationships among them. The variables considered most significant in anxiety research are (1) the external and internal stimuli that evoke states, (2) the cognitive processes involved in appraising stimuli as threatening, and (3) the defense mechanisms employed to avoid anxiety states, or reduce the intensity of these states once they are experienced.

The principal assumptions of the Trait-State Anxiety Theory may be briefly summarized as follows:

1. In situations that are appraised by an individual as threatening, an A-state reaction will be evoked. Through sensory and cognitive feedback mechanisms, high levels of A-state will be experienced as unpleasant.
2. The intensity of an A-state reaction will be proportional to the amount of threat that the situation poses for the individual.
3. The duration of an A-state reaction will depend upon the persistence of the individual's interpretation of the situation as threatening.
4. High A-trait individuals will perceive situations or circumstances that involve failure or threats to self-esteem as more threatening than will persons who are low in A-trait.
5. Elevations in A-state have stimulus and drive properties that may be expressed directly in behavior, or that may serve to initiate psychological defenses that have been effective in reducing A-state in the past.

6. Stressful situations that are encountered frequently may cause an individual to develop specific coping responses or psychological defense mechanisms which are designed to reduce or minimize A-state.

Anxiety-as-process

The concept of Anxiety-As-Process refers to a complex personality process which is a sequence of cognitive, affective, physiological, and behavioral events that may be initiated by a stressful external stimulus or by an internal cue that is perceived or interpreted as dangerous or threatening by an individual. Cognitive appraisals of danger are immediately followed by an anxiety state reaction or by an increment in the level of A-state intensity. While an anxiety state is at the core of the anxiety process, this process also involves stress and threat as fundamental constructs or variables. In essence, the theory implies the arousal of the anxiety as a continuously emotional development process which involves stress, threat, and trait and state anxiety as a whole. Sieber (1977) diagrammed the anxiety-as-process as follow:

Evaluative situation $\Rightarrow$ Perception of situation $\Rightarrow$ Anxiety state reaction =

$\Rightarrow$ Cognitive reappraisal $\Rightarrow$ Coping, defensive or avoidance behavior

Stage 1. An evaluative situation arises. This is a potential stressor or cause for anxiety.

Stage 2. The evaluative situation is perceived by the individual. Depending on the nature of the evaluative situation and the individual's prior learning, he/she may perceive it as dangerous, that is, as a situation in which he/she is likely to perform inadequately and perhaps fail and suffer a loss of self-esteem.

Stage 3. An anxiety-state reaction occurs if the individual regards the situation as dangerous. The complex of responses known as the anxiety-state reaction involves a set of physiological responses, and a conscious preoccupation with these physiological changes and with the stressor. It also includes feelings of distress, helplessness, and worry about the inability to do well, and sometimes a feeling of self-depreciation and shame. It is apparent, then, that the appraisal of a particular situation as stressful and/or threatening will be determined by an individual's past experience with similar situations, as well as by the objective stimulus characteristics of the situation.

Stage 4. Cognitive reappraisal follows. The individual reappraises the stressful conditions to try to find a way to deal with them. He/She may find a constructive coping mechanism for alleviating the stress, or he/she may find a defensive or avoidance behavior that enables him/her to escape the anxiety arousing condition.

Stage 5. Coping, avoidance, or defensive behavior is then engaged. For example, the individual may find a way to solve the problem effectively; deny his feelings of anxiety and blunder ineffectively through the task; or leave the situation entirely.

It seems more appropriate to consider anxiety as an emotional process in which stressful stimulus conditions, as well as the anxiety reactions, are included. However, the emotional process definitions of anxiety tend to lead to some problems-- the variety of components or variables which are involved in an anxious process. Those components or variables probably differ in each unique situation or condition. Therefore, it is difficult to establish a standard definition for all of the situations, and to compare and integrate research findings based on process definitions of anxiety. However, there are various researchers who continuously devote their effort to this subject area.

Definitions and measurement of anxiety

A good way to understand comprehensively the meaning of a psychological construct perhaps begins from the defining and measuring of that construct. Since anxiety is a psychobiological concept, both physiological and phenomenological indicants are required. Various definitions and measurements have been developed and validated during the past three decades. It has come to be generally recognized that (1) the concept of anxiety is not a simple one, but involves a number of complex, interrelated aspects; and (2) the development of adequate anxiety assessment devices cannot be accomplished casually; it requires the full application of modern test construction methodology. Four major ways in which anxiety may be defined and measured are discussed:

1. The phenomenology of anxiety--the individual's conscious awareness of the anxiety reaction   Typically it is measured in self-report forms which focus on feelings (rather than on somatic symptoms) of anxiety (or its absence). The earliest effort to construct measures of the subjective feelings of apprehension, tension and worry that define the phenomenological component of anxiety were carried out by Nowlis and Green (1965), Cattell and Scheier (1961), Zuckerman (1960), and Zuckerman and Lubin (1965). At the present time, Zuckerman's Affect Adjective Check List and the State-Trait Anxiety Inventory (Spielberger, Gorsuch & Lushene, 1970) are the self-report instruments most widely used for assessing the phenomenological component of anxiety.

There is a need, however, for the development of additional specific anxiety measures. An example of such an instrument would be one that broadly sampled particular areas of stimulus input (e.g., computer anxiety, mechanical anxiety), in order to specify the particular areas in which one is most prone to anxiety.

For the reason that it is easy to manipulate and to attain good reliability and validity, the self-report (pencil-paper) measure will remain the most widely used technique for measuring anxiety.

Unfortunately, the self-report measurement usually ignores the fact that anxiety arises as a function of interaction between the person and the environment.

2. _The physiological responses of anxiety--the autonomic physical aspects of the anxiety reaction_ These responses include galvanic skin responses, changes in heart rate, blood pressure, muscle action potential, palmar sweating and respiration rate. Various measures of autonomic nervous system activity have been employed in attempts to assess the physiological aspects of A-State. These have been reviewed by Martin (1961), Levitt (1967), McReynolds (1968), and Lader and Marks (1971). In terms of the volume of research, the Galvanic skin response and changes in heart rate appear to be the most popular physiological measures of A-state. However, researchers have been unable to adduce conclusive evidence of any specific patterns of physiological activity that regularly accompany the phenomenological components of anxiety.

As Endler and Hunt (1968) have shown, whether or not anxiety is manifested in physiological changes varies between individuals and is idiosyncratic to the eliciting stimulus within each individual. Many studies that have used physiological measures, along with other measures of anxiety, have noted no significant physiological differences as a function of other measures of anxiety. (For example, Hodges & Spielberger, 1966, using heart rate; McReynolds, Acker, & Brackbill, 1966, using basal conductance and palmar sweat; Weinstein, Averill, Opton, & Lazarus, 1968, using skin conductance; O'Neil, Spielberger &

Hansen, 1969, using systolic blood pressure.) This is not to say that there is no physiological basis for anxiety. It does suggest, however, that the role of physiological responses in the anxiety development process have not yet been determined conclusively.

Hodges (1972) suggests that the relationship between how a person feels and how he/she responds physiologically is very complex. Behaviorists disallow the verbal report measures and tend to prefer physiological measures as more acceptable response measures. Cognitivists tend to accept the phenomenological variables as more relevant to the emotional changes and dismiss the physiological measures as too complex or less sensitive. There is a striking need for using both measurement methods for studying anxiety to see if they are interchangeable. But the conditions should be equivalent and induced, or else base anxiety should be concerned separately (McReynolds, 1972). However, most of the anxiety researchers did not employ a physiological measure based on the following practical difficulties:

1. There are extensive problems in recording and interpreting physiological data due to such phenomena as "floor" and "ceiling" effects, physiological adaptation to the stimuli of anxiety, and artifacts due to various forms of electrical interference in even the most carefully controlled laboratory situations.

2. It is not feasible to locate physiological recording equipment in school settings, to have electrodes attached to students while they attempt to do academic work, or to require students to engage in the

long waiting periods required to obtain steady baseline measures. Telemetric devices, which do not require the use of electrodes, are extremely expensive.

3. The cost of using such equipment and of obtaining the necessary staff of engineers and technicians to operate it would be prohibitive, particularly in field settings where most of this research has to be performed.

3. Task performance--an measure of task performance, including measure of cognitive mediating process Such measures may be indicative of the nature of the cognitive reappraisal and the effectiveness of the coping mechanism that the individual employs following reappraisal. Any stage of the problem-solving process may be assessed, as well as the speed, accuracy, and efficiency with which it occurs. A Human-Figure-Drawing test of anxiety (Roback, 1968) is a typical example. Some specific components of task performance, such as short-term memory, development of attention, incidental learning, and divergent thinking are useful in defining the construct of anxiety in a test situation. However, many of these effects need to be proven reliable enough to serve as an operational definition of anxiety.

4. The conditions which affect the anxiety process--the internal and external stimuli which affect the anxiety reaction These conditions may be modified through training, instructions, or curriculum design. The measurement includes the objective characteristics of the evaluative situation, the prior experience of an individual insofar as

if affects his/her perception of the evaluative situation, the character of his/her anxiety reaction, the nature of reappraised responses, and the kind of coping defense or avoidance response made. This approach to defining anxiety encompasses the modification of anxiety and its effects through training, therapy, or instruction and curriculum design is of greatest practical interest in education.

After the above brief discussion of the measurement of anxiety, it is reasonable to conclude that the measurement of Anxiety-As-Process requires the assessment of each of the variables that are specified in the process theory. In addition to measures of state and trait anxiety, the evaluation of anxiety-as-process would involve the measurement of objective stress and the cognitive appraisals and reappraisals that determine the subjective threat that is experienced by an individual; also it is necessary to take into account coping and avoidance behaviors and psychological defenses that serve to alleviate state anxiety. Thus, progress in research on anxiety will require a comprehensive theory that articulates the relationships among the fundamental variables that define these areas and the specification of precise operations for the measurement of the critical variables that influence anxiety and its effects on behavior.

Interactions and effects of anxiety

The analysis of anxiety and other personality or individual difference variables, as well as their interactions, is useful in identifying ways of facilitating learning and performance.

Anxiety and sex   Traditionally, males were likely to be trained to cope with anxiety by denying it and by autonomic preparation for physical activity, so that a muscle relaxant was actually a disturbing, rather than calming, influence. Females, on the other hand, were more likely to be trained to acknowledge anxiety and to express dependency. Thus, answers to an anxiety questionnaire might mean quite different things to the two sexes, and their respective styles of coping with anxiety might also affect performance differently. Such sex differences may well be reduced as our child-rearing patterns change, but in the meantime, they may provide some handles for getting at the psychological variables affecting the relationship between anxiety and performance.

Anxiety and personality   Research suggested that anxiety-proneness is related to certain broader personality tendencies, which may be thought of as personality styles. Researchers have found that anxious individuals tend to have low self-esteem, are more prone to feelings of guilt, have less curiosity and less sensation-seeking behavior, daydream more often, and are more resistant to hypnosis. These findings, however, are derived from investigations that are independent of each other. It would be erroneous to conclude that the various styles actually are aggregated in a constellation. That is, the evidence does not indicate that these styles characterize the anxious person.

According to this line of reasoning, there is probably no one "anxious personality," but there may be several different "anxious personalities," each comprising different styles or traits. Such a hypothesis can be truly examined only in multivariate experiments in which the interrelationships among anxiety and a number of personality factors are investigated simultaneously.

Anxiety and parent-child relationship Childhood experiences influence the development of individual differences in A-trait, and parent-child relationships centering around punishment are especially important in this regard. The fact that self-depreciating attitudes are aroused in high an A-trait person under circumstances characterized by failure or ego-involving instructions, suggests that individuals who received excessive criticism and negative appraisals from their parents tended to undermine their self-confidence and adversely influence their self-concept.

Anxiety and intelligence Sarason, Lighthall, Davidson, Waite, and Ruebush (1960), in their study of anxiety in elementary school children, noted a decrease in measured IQ following increases in anxiety and an increase in measured IQ following reduction in anxiety.

On the other hand, Spielberger (1966), using college students, found that among the very brightest students, those who were highly anxious obtained slightly higher grades than those who were rated low in anxiety. Among the students with less ability, however, those who were rated high in anxiety tended to obtain lower grades than those who were low in anxiety. Spielberger pointed out that one plausible explanation of these results was that the course work, on which these results were based, was easy for the bright students and difficult for the less able students; hence, there were differential effects of anxiety on performance.

Anxiety and memory A specific process that appears to be influenced by anxiety is memory. Highly test-anxious persons tend to do relatively less well on problems requiring memory (for example, recalling the outcome of previous trials, or a set of facts that are to be used in a subsequent aspect of the problem). However, they perform at least as well as low-anxious persons when memory support is provided (Sieber, Kameya, & Paulson, 1970).

Anxiety and attention Wine (1971) suggested that anxious persons are more selective attenders than are non-anxious persons. Specifically, anxious individuals tend to focus their attention on the individual who is evaluating them, on their own concerns about failure, and on the task they are supposed to be doing. Their attention is thus limited to certain classes of cues, and incidental learning is relatively less likely to occur (Easterbrook, 1959).

Anxiety and learning It has been noted that anxiety affects learning. Hull (1943) and Spence (1958) postulated that anxious persons are emotionally responsive. If an individual is anxious and under the appropriate stimulus conditions, a well-learned response is most likely to be made. However, complex and subtle learning tasks can be readily envisioned in which learned responses are to be given to various similar stimuli, such that for each stimulus, there are several competing responses from among which the correct responses must be chosen. High anxiety or emotional responsiveness would only add to the confusion and difficulty of such tasks. Research supports this supposition, showing that anxiety and task complexity interact in their effect on performance: anxiety facilitates the learning and performance of simple responses, and hinders that of complex responses (Spence & Spence, 1966; Goulet, 1968).

Anxiety, intelligence and learning For subjects with superior intelligence, high anxiety will facilitate performance on most learning tasks. While high anxiety may initially cause performance decrements on very difficult tasks, it will eventually facilitate the performance by the more able subjects as they progress through the task and correct responses become dominant.

For subjects of average intelligence, high anxiety will facilitate performance on simple tasks and, later in learning, on tasks of moderate difficulty. On very difficult tasks, high anxiety will generally lead to performance decrements.

For low intelligence subjects, high anxiety may facilitate performance on simple tasks that have been mastered. However, performance decrements will generally be associated with high anxiety on difficult tasks, especially in the early stages of learning. Since earning good grades in school is relatively difficult for most students, it follows that high anxiety will generally interfere with academic achievement, and most studies of the relationship report negative correlations.

Anxiety, defensiveness, and learning   Observations by Sarason, Hill, and Zimbardo (1964) suggested that while anxiety, per se, may have highly undesirable effects on the performance of school children, defensiveness may have additional bad effects on their performance. Sarason (1966) reasoned as follows: "...anxiety is such a compelling experience that it can give rise to a pattern of reactions which, however painful and self-defeating in their consequences, reduces the likelihood of experiencing the anxiety again."

Sarason went on to speculate that it was defensiveness (a way of avoiding anxiety and, incidentally, of avoiding the problem itself), that may account for much of the decrements in learning and performance of anxious children. Sarason noted that defensiveness was a result of socialization to hide one's manifestations of anxiety, and began to develop at about the onset of middle childhood. Hill and Sarason (1966) examined the relationship between various ability measures on one hand, and anxiety and defensiveness on the other. As predicted, a high level of defensiveness, at every level of (admitted) anxiety, was accompanied by a decrement in performance relative to the performance of low-defensive children.

Anxiety and performance   The most consistent general finding noted in previous research was that high anxiety is associated with relatively low performance at both the school and university level. This conclusion was based on the negative correlations that were obtained in a number of different studies between different measures of anxiety and a variety of measures of academic aptitude and achievement.

For elementary school children, the evidence suggests that negative correlations between anxiety and achievement tend to increase in size for the higher grade levels, provided that the anxiety scales are given in reasonably close proximity to the achievement test. In addition, the following three tentative conclusions appear to be supported by research findings:

1. reading is more strongly associated with anxiety in the earlier grades than is arithmetic;
2. arithmetic (mathematics) becomes increasingly associated with anxiety toward the end of the elementary grades; and
3. differential relationships between anxiety and performance for boys and girls may depend upon situational factors.

At the college level, there is evidence that anxiety tends to be associated with lower grades and higher dropout rates. Anxious students in the middle ranges of ability obtain lower grades and have a high percentage of academic failures than do non-anxious students of comparable ability. Students of low ability earn poor grades irrespective of their anxiety level; however, a higher percentage of these students, with high anxiety, are more often academic failures than are the non-anxious students of limited ability. For very superior students, it appears that anxiety may actually facilitate academic performance. To the extent that anxious students who are likely to be under-achievers or academic failures can be identified early and if offered effective remedial assistance, academic mortality rates resulting from emotional factors can be reduced.

Computers and Education

Computers were originally developed as a research tool to perform mathematical calculations in an automatic manner. Initially, their primary asset was speed, and their primary use was to expedite routine calculation. They were soon used by business and industry in a similar way to maintain records, generate reports, control machine tools and perform activities designed to save human labor. It required several years of considerable technological development and extensive experience before the computer's role was expanded from performing routine tasks to assisting with creative ones.

Today, computers are widely used in education as well as other professions. Why do computers become so important in education? We are in the midst of a major revolution in our society, and computers play a major role in that revolution. Society is shifting from an industrialized to an information-oriented era. It is important for average people to be able to acquire, manipulate, process, and distribute information. The assets of computers will assist people in being more successful in today's information age.

In spite of the continuous debates of educators, it is apparent that educational computers are so efficient, so inexpensive, and so powerful that they can, within current budget limitations, significantly improve the performance of the education system and help accomplish the current educational goals that is to teach more topics and more skills to more people. However, computer, while widely used in education at all levels, could lead to a better future or a worse future. At the present time, the critical aspect of the abuses of computers in education is not the computer itself, but the way people choose to use it (Bork, 1984c; Thomas, Boysen & Thomas, 1984).

The review of computers in education will focus mainly on the current uses and further applications of computers in instructional processes. Potential, limitations, as well as possible problems, will be discussed as inclusively as possible.

Why computers in learning

Why is the computer destined to be such an important factor in human learning at all levels with all types of people? Fundamentally, the major factor is INTERACTION. The fact that the computer can make learning an ACTIVE as opposed to a passive process, implies other important consequences.

Learning must be active if ideas, methods, and concepts are to be internalized. To be useful to the individual, learning must involve some activities on the part of the learner. A learner, or a small group of learners, working with a human tutor, can maintain such activity. But most of our current learning situations tend to be passive, where many people need to learn and limited funds support learning institutions. The computer allows us to move away from spectator learning at reasonable cost and to return to interactive learning for everyone. This is not to say the computer competes well with an extremely good tutor. We can, however, with computers, become more interactive than is usually possible.

Computers can accomplished many educational goals:

First, the capability of a computer to engage students in a highly motivating and intellectually active dialogue, to provide appropriate instructional stimuli on an individualized basis, and to provide diagnoses and feedback both to the student and to the teacher.

Second, the capability of a computer to create intellectually simulating environments for students to explore subject matter generally foreign to the current curriculum, perhaps beyond the competency of the teacher, but important and useful for the student's future life.

Third, the capability of a computer to provide each student with the resources of a library, a librarian, a typewriter, and a personal editorial assistant--convenient, accessible, and easily used--that teaches the student skills that may be necessary for subsequent adult responsibilities.

Fourth, the capability of a computer to provide learning experience and opportunities through simulations--experiences that would otherwise be too costly, too risky, too time consuming, or not possible. People often learn best by participating in a system rather than merely being a spectator. Computers provide a way to get close to actual participation without the costs or risks of actual participation.

Finally, the capability of a computer to foster, in a generation of young adults, the capacity to perform analytic tasks and solve important organizational problems involving information far better than older generations because they receive an early and continuous exposure to concepts and specific tools for computer-assisted problem solving.

Computer supported learning

The highest goal of computer application in education is to develop the student's capability for using the computer to enhance thinking. A common example is the development of computer-based models which a person can study through successive manipulation and observation. Essentially, an efficient and effective learning model possesses two unique features: being integrated in the curricula and meeting the needs of learners.

A taxonomy for using computers to support learning has been developed to identify and emphasize a stronger role for the computer in the instructional process. The classifying variables in the taxonomy are based on the status of the learner with respect to the knowledge, skill or attitude to be learned. Five categories are included: experiencing, informing, reinforcing, integrating and utilizing. Each category represents a possible step in the learning process. For some learning experiences with certain students, all categories may be necessary to promote adequate learning, whereas in other situations, only two or three categories may be required. This taxonomy, founded on student need, has become a variable tool for both the designer of courseware and the instructor who use it (Thomas & Boysen, 1985a).

Experiencing Experiencing programs are used to set the cognitive or affective stage for future learning. They usually encompass a model of a concept, subject area, or situation which the student can manipulate in order to gain an intuitive understanding of the learning goal. Experiencing programs can be used to (1) provide motivation, (2) provide an organizing structure, or (3) serve as a concrete example. In each case, the student uses the computer to explore an unknown entity. Experiencing lessons are student-directed, thus having the potential of producing a different outcome for each student. As a result, they are very rarely "student-alone" learning experiences but are designed to enhance the meaning, and hence the transfer of the formal learning which follows. To be successful, experiencing lessons must capture the attention of the student and must reflect the important intellectual structures on which they are based.

Informing   Informing programs are used to transmit information to the student. These programs supplement or replace the textbook and lecture as means of initial formal exposure to a topic. Through careful design, these programs can map the student's existing knowledge and fill the gaps therein. Informing programs are of four basic types: tutorial, demonstration, inquiry and dialogue. Most informing applications are computer-directed, providing stimuli to which the student must respond. In actual practice, they frequently degenerate to page turning applications for which the computer is of questionable value over programed instruction. In the academic environment, informing lessons appear most useful for remediation and distance learning.

Reinforcing   Students use reinforcing programs to strengthen specific learning objectives. The most obvious format for a reinforcing program is drill and practice, in which a sequence of stored or generated exercises are presented for the student to complete. These programs can be designed to adjust to the knowledge level of the student and to track the student's progress. The use of reinforcing lessons is restricted to areas where repeated practice is required. Like informing applications, these lessons are computer-directed with the student responding to the stimuli presented.

Integrating Integrating programs are designed to aid the student in making the necessary associations. Integrating programs are usually simulations which are manipulated or directed by the student. They are appropriately used in any situation where several knowledge elements are learned independently and need to be applied collectively. Due to the segmented nature of most instruction, this is potentially the most important category in using the computer to aid learning. Since this type of learning so closely parallels the creative activity of practicing professionals, it would appear to be the best vehicle for promoting the computer as a thinking tool.

Utilizing Once a student has learned a process, that process may be incorporated into a computer program and used as a tool. The utilizing category is intended to include body textual and numerical application. For classroom use, these programs enable students to tackle more complex and realistic assignments. They permit greater classroom focus on the central issues of the discipline by minimizing the need to focus on computations. Proper use of these tools contributes significantly to computer-supported thinking.

It is important to note that experiencing, integrating, and utilizing applications are student-controlled, whereas informing and reinforcing are computer-controlled. In developing the ability to use the computer to augment the thinking process, it is clear that student-directed applications hold much greater potential than those directed by the computer. Students must learn to make the computer their servant.

Computers in the schools

Computers are used heavily in some educational areas. In other areas, uses are only now being explored and expanded. Basically, there are four broad areas of educational applications: computer-assisted instruction (CAI), computer-managed instruction (CMI), staff development, and administrative uses. Discussions will emphasize computer-supported learning which is a broad concern of computer-assisted instruction in schools.

Current status Three nationwide surveys concerning the usage of computers in education were conducted from 1982 to 1984. Findings were summarized as following:

Microcomputers in School, by Schimizzi (1983) at State University of New York at Buffalo. Four hundred schools were randomly selected from Patterson's American Education Directory. Findings are based on 141 schools.

1. Microcomputers were available to most learners (71%) either in the classroom or in a laboratory situation.

2. Most students (51%) spent from 15 to 60 minutes per week with the microcomputer.
3. Microcomputers were used in all areas of the curriculum including music and art. The highest demand areas in order of the heaviest use were mathematics (34%), reading (18%), language arts (17%), and the social studies (12%).
4. The microcomputers were most often used (81%) for drill, practices, mastery learning, problem solving and creativity through interaction with a problem solving situation. Only eleven percent of the respondents indicated that they were teaching programming.
5. The overwhelming majority (86%) of the respondents indicated that microcomputers enhanced their ability to individualize instruction.
6. Sixty-six percent of respondents indicated that using microcomputers improved children's motivation to learn; 40 percent of them perceived that the children's behavior was improved.
7. In varying degrees, the microcomputers were used by all children including the statistically average children, the gifted children, the slow and retarded children, and the physically handicapped children. The most often used applications were to challenge the gifted.
8. Nearly half (44%) selected the Apple computer as the first priority to purchase; 32% selected Radio Shack TRS-80.
9. Programming was taught for a variety of reasons including the fostering of computer literacy (28%), problem solving (20%),

occupational value (20%), creativity and the internalization of concepts (17%). Most teachers (76%) who were teaching a programming language indicated that they were teaching BASIC. An overwhelming majority (82%) of the respondents indicated that some kind of in-service training in microcomputers was available to teachers.

10. Most the decisions concerning the purchase of courseware were made by both the teachers and the administrators (44%). Twelve percent were made by teachers only. Twenty-three percent was made by administrators only.
11. The computers were financed by a combination of local, state and federal funds--mostly local and federal funds (40%).
12. Most of the respondents (65%) indicated that they would not have microcomputer assisted instruction in their schools if microcomputers were not available.
13. The years 1985-1987 were most often (39%) indicated as the dates when microcomputers were expected to be available in every classroom, 25 percent indicated in the years of 1988-1990.

School uses of microcomputers, by Becker (1983a) at Johns Hopkins University. Sixteen hundred schools were selected from microcomputer-owning public and non-public elementary and secondary schools. Findings are based on 1082 schools.

1. By January, 1983, 53 percent of all schools in the United States had obtained at least one microcomputer for use in instructing students. Eighty-five percent of all high school, 77 percent of all junior-

senior combinations and 68 percent of all middle and junior high schools had one or more microcomputers. The corresponding figure for elementary schools rose to 42 percent during the same period. Secondary schools are becoming new users at a faster rate. Secondary schools with five or more computers have doubled the number of computers from June 1980 to January 1983. In 1983, elementary schools were where secondary schools were in 1981. The least likely owners of microcomputers are small parochial elementary and public schools in poorer districts.

2. Regarding the five uses of computers, the difference between secondary and elementary schools varied slightly.

	Secondary	Elementary
Introduction to computers	85%	64%
Programming instruction	76%	47%
Drill and practice	31%	59%
Business and vocational	29%	-
Programming to solve problem	29%	27%
Tutoring for special students	-	41%

3. Schools with microcomputers experience lean toward programming uses and view computers as primarily a "resource" for students to learn more about computers other than a "tool" to help teachers to teach basic skills.

4. The greatest impact of microcomputers has been more on the social organization of learning than on increased student achievement per se, and the above-average students have learned the most. The social impacts include: increased student enthusiasm for schooling;

more independently work, without assistance from teachers; helping one another and answering each other's questions; and doing work more appropriate to their ability level.

5. In about half of the schools with microcomputers, only one or two teachers, at most, are regular users. In half of the elementary schools and 70 percent of the secondary schools, at least one teacher spends time writing or designing computer programs for use with students.
6. The typical microcomputer-owning elementary schools has two microcomputers, each used for about 11 hours per week by students under the direction of a teacher or other staff member, About 62 students (in the student body of 400) share these 22 hours of use, which is equivalent to about 20 minutes per use per week. As schools get more microcomputers, they provide access to more students. Approximately 40 percent of all instructional time on the microcomputers is spent by having students use computer programs for practicing math and language facts, spelling drills, and various other memorization tasks. Approximately one-third of the time is spent having students copy, write, and test computer programs. Students spend most of the rest time (20%) playing games under the direction or approval of the teacher.
7. The typical secondary school has approximately five microcomputers, each in use for 13 hours per week. About 80 students (in a student body of 700) use the equipment on an average of 45 minutes per user

per week. Programming and computer literacy activities occupy fully two-thirds of the instructional time. Drill and practice activities take up another 18 percent and the remainder is split among learning games, various advanced applications such as word processing, science lab work, business courses, and other activities.

8. Before 1982, the initial impetus for obtaining microcomputers most often came from a single teacher. More recently, administrators have been playing a larger role in initiating first purchases.
9. The most common location of microcomputers is the classroom, but nearly half of schools do not put microcomputers in regular classrooms. Keeping microcomputers solely in classrooms has largely negative consequences, although equity of use is improved for secondary schools. Putting computers into a laboratory situation, in contrast, has generally positive consequences, except for equity.
10. Students spend slightly more than half of their computer time (54%) working individually rather than in pairs or in groups; but most of the time that students work at computers (67%) they are in a social situation anyway, either working in pairs or groups or getting frequent help while doing individual work.

Usage of computers in education, by McGraw-Hill Research Group (1984). The samples consisted of 2000 educators who were selected from Market Data Retrievals Universe of United States educators. Findings are based on 1323 usable responses.

1. Seventy-seven percent reported their schools own computers, 42 percent reported that their school planed to buy a computer. Only 13 percent reported that their schools do not own and do not plan to buy a mini or microcomputer. Among the computer-owning schools, 74 percent own microcomputers, five percent own computer terminals connected to a minicomputer, and two percent own computer terminals connected to a large computer. On the average, the computer-owning schools own 4.5 microcomputers, 4.3 terminals connected to large minicomputers and 4.1 computer terminals connected to large computers. Among the schools planning to buy a computer, 51 percent intend to purchase microcomputers, five percent plan to buy computer terminals connected to minicomputers and one percent plan to buy terminals connected to large computers.
2. The largest percentage of primary usage of computers are the following:

    Drill and practice (69%)
    Math (66%)
    Enrichment (60%)
    Remedial work (57%)
    Computer literacy (56%)
    Games (55%)
    Teaching reading (45%)
    Language arts (44%)
    Problem solving (43%)

3. Nearly one-half of the educators (49%) reported that they personally use computers for teaching and teaching-related applications. And 55 percent of those now not using computers for teaching applications plan to use them in the next 12 months.

4. Nearly all (85%) respondents who personally use computers for teaching applications indicated that they use their computers for drill and practice.
5. Eighty percent of respondents indicated that the decision to purchase one or more types of computer hardware and software was done by committees in their schools.
6. More than half (54%) of the respondents reported that their school's computers were located in classrooms.
7. An average of $6,460 was spent by respondents' schools in the past 12 months on computers and peripheral equipment. An average of $1,291 was spent on computer software.
8. Sixty-four percent of respondents' schools own and use Apple computers; 20 percent use Commodore; 19 percent use Radio Shack; 11 percent use Texas Instruments, 5 percent use Atari and 2 percent use IBM. Of those schools that plan to buy computers, the leading brands were Apple (37%), Commodore (13%), Radio Shack (7%), IBM (4%), Franklin (3%) and Atari (2%).
9. Fifteen of the respondents' schools use or plan to use networking.
10. Funding to introduce expanded computer facilities came or will come from the following sources: school district budgets (53%), cooperative fund raising (44%), federal government grants (24%), state government grants (13%), and cooperative programs with business and industry (6%).

Another series of computers in education surveys were conducted in Nebraska at the University of Nebraska-Lincoln in 1979, 1981 and 1982. Educators participated in these studies were not positive about the intensive future for use of computers in their own classrooms, although they did perceive that computers would strongly influence classroom instruction and the curriculum in the near future. A need for computer training in teacher preparation and in-service programs was indicated by a majority (70%) of the subjects surveyed in 1982. Only a few subjects rated themselves as qualified to use computers in their teaching.

Educational potential and limitations of microcomputers

This section will outline some ways that microcomputers can contribute to the quality of instruction and will also identify some of the problems that limit their usefulness.

Potential

More active learning Computers are interactive. A computer is not merely a medium for presenting materials to be learned or simply a medium of expression for students. It is both, and more. By the interactivities of computers, reinforcement of learning is immediate and systematized, which should result in more effective learning. One of the most consistent findings of educational research is that learning of all kinds is enhanced when learners can do something with what they are learning and see the results of what they have done. Computers can be programmed to call for repeated input from users and to respond immediately to that input. Thus, students can attempt learning activities and can receive feedback on their attempts--a level of activity not possible when applying the traditional methods.

Learning with less mental drudgery Mental drudgery is doing things that a person already knows how to do and that is not fun. It used to be widely thought that such drudgery aided moral development. Today, this view is out of fashion, but much drudgery still seems unavoidable in education--rewriting and retyping drafts of a paper, searching the library card catalog and then the shelves for the books one needs, and so on. A word processor and a data search and retrieval program can eliminate enough drudgery to concentrate on planning and strategic skills that make realistic problems manageable for youngsters.

Better aids to abstractions Computer graphics and computer simulation are powerful new means of representing ideas and relationships in ways that permit a person to act on them and to see the consequences. Computers can be programmed to create model worlds that operate according to a combination of strict rules and random processes and to give students complete control over them. These simulated worlds should be powerful aids to conceptual learning and thinking, enabling students to learn abstract relationships more easily than by merely reading about them. The act of programming itself can also be an aid to understanding abstractions. When we write a program, we represent complicated processes precisely and directly. Even writing a simple program is a form of abstraction that is closely akin to action, and for that reason it may be more accessible to young people than the static symbolic forms instructors have traditionally struggled with.

More independent learning Computers offer students new possibilities for independent verification of their own progress. The most serious challenges of independent learning are verifying progress and sustaining motivation. Programs can be written to monitor students' progress through lessons, to note errors and offer extra practice or more instruction where performance is weakest, and to offer help and advice whenever students ask for it.

Learning nearer to the needs of individuals When a encounter of new information, whether live or recorded, is presented at exactly the right pace, the attention does not wander, nor does fall behind. It follows the train of thought seemingly without effort. Properly programmed, computers can match the pace and timing of a presentation to a learner's requirements at a given moment. The result is saving time; an average time saving of one-third is typically found in comparing computer-based education programs with conventional ones (Walker, 1984). Moreover, satisfaction, pleasure, and confidence in learning increase. The computer makes one key goal of educational reformers, individualized rates of learning, routinely attainable.

Individually tailored It is possible to program a computer to compose a lesson on the spot, tailored to the responses of just one student, using rules for selecting combining preformed components, according to the student's prior responses. When learning difficulties are not remediable, as in the case of handicapped students, computers can circumvent individual limitations and concentrate instead on individual strengths. In this way, learning becomes more motivated and effective. As the amount and sophistication of material to be learned grows, each of the students will encounter their own limitations more often. They can all benefit from extending their performance with the aid of computers.

More varied sensory and conceptual modes Microcomputers as they come from the store can display letters and simple shapes in color; they can play single tones of varying pitch, duration, and loudness. They will accept input from typewriter keyboards, game paddles, joysticks, light pens, or digitized drawing pads. They can be connected electronically with any device that can be made to generate or respond to an electronic signal. For example, equipment is now available that can link microcomputers with videotape or videodisc players, electronic musical instruments, scientific instruments, physiological monitoring equipment, household appliances, and other computers. This makes a computer an enormously versatile teaching tool.

Limitations

Microcomputers can supplement conventional education, but they cannot substitute for it Independent study, home learning, and distance learning all have low rates of completion. Their chief problem is to sustain motivation and participation in the absence of a learning group, a teacher, or a social structure. Although computers have generally been used successfully in the ongoing classes, the leap from this supplementary use to independent study via computer is a giant one. Even though computers seem to ease the problems of distance learning, the schools are a long way from sustaining a mass educational system via computers. The implementation of telecommunication and data communication techniques in conjunction with a carefully designed curriculum probably will accelerate the availability of distance learning.

Today's microcomputers are hard to use and teachers prepared to use them are in short supply Almost every teacher currently teaching in the schools was trained before computers were widely used in the classroom. Even today, very few schools of education have adequate programs in this area. Society is faced with a sizable problem, retraining almost all of the teachers to understand the capabilities of the computers in education.

Walker (1984) stated that from his experience at Stanford University during the past two summers, highly motivated teachers can learn to use microcomputers for CAI, learn to program in BASIC, and learn to work with youngsters in computer literacy and computer programming courses in six weeks of full-time study, six hours a day, five days a week--a total of 180 hours. Perhaps this figure could be reduced somewhat by careful planning. But what remains would still require more hours of study than any single semester-long college course.

And such a course of study is only the beginning for an educator who wants to use computers professionally. Each computer has its own way of doing things, which must be learned anew regardless of prior experiences. Each of the computer languages in widespread use requires further hours of study. Although each new round of products is more "user-friendly," it will be years before microcomputers are as easy to use as movie projectors--machines that frequently are already too complex for many teachers.

New products and system are being created and marketed in such profusion, with such speed, and with so little standardization that systematic, long-term planning is nearly impossible When products are changing rapidly and each one has its own peculiarities, the return on the investment of time and energy in learning to use the system is low. Schools do not have the resources to provide continuous in-service training for ever-changing computer systems, nor will teachers continue definitely to give up their spare time.

In addition, software and accessories purchases for existing machines may not work with the next generation, and they will certainly be incompatible with competitors' machines. This factor makes long-term planning nearly impossible and militates against the economies of scale that could come from coordinated programs of adoption and purchase. Hopefully, standardization will eventually come to the computer industry.

Scarcity of quality CAI material to share The majority of CAI courseware currently available is developed by individual faculty members for specific purposes. It has largely been written in a machine-dependent language and is undocumented. Thus, this courseware is difficult to share and is protected by a copyright if it is of significant value. A study reviewing over 4,000 CAI programs written in BASIC found that only about three or four percent were acceptable by faculty in the fields concerned.

It is apparent that an individual, especially today's classroom teacher, will not be able to develop a high quality courseware because of the limitations of training, time, and budget. Chambers and Sprecher (1984) believe that a team approach, using at least three faculty members, a programmer, and an instructional designer, has the best chance of developing courseware which will be acceptable to the greatest number of faculty and students. Many companies also produce instructional computer software but the quality, as a whole, is appalling (Bork, 1984c). Although review of software has become popular, the improvement is slow, and a shortage of good software will continue (Walker, 1984; Bork, 1984a).

Programs for teaching explicit, format models can be created readily with known technique, but it is much more difficult to use computers to teach subject matter that involves judgment, intuition, improvisation, and creativity Computers handle rule-base procedures more quickly and accurately than any human being can, once the system of rules and procedures has been worked out. Using today's computers, educators can construct quite complex formal models, and these can be used to help teach students how to work with formal systems of knowledge. But not all systems, literature, the arts, mathematical invention, and scientific applications are unformalized and not yet reducible to formal rules and procedures. The study of those parts requires a broad or deep understanding of human interaction. Computers can be used to help teach these "soft" subjects, but their application is neither simple nor straightforward.

The field of artificial intelligence takes upon itself the task of discovering the extent to which those human capabilities, regarded as intelligent, can be represented in rule-governed procedural models and therefore programmed for computers to carry out. Perhaps at some point people will discover that everything now regarded as intelligent about human behavior can be programmed for computers. Even though, a student working with a qualified human teacher is more appropriate than an intelligent and powerful machine.

<u>Microcomputers will not solve several of the most serious current problems confronting education--notably equity, school finance, and divergent public expectation</u> Computers will not bring racial balance to segregated schools or racial harmony to integrated ones. They will not redress inequities in funding between schools in rich and poor areas, nor will they overcome subtler inequities in the quality of education that stem from differences in race, ethnic group, gender or

socioeconomic class. Funding levels for education do not appear likely to rise because of computers. Rival segments of the public will continue to hold contradictory expectations for schools and to struggle to impose their own views on the schools. Teachers will continue to be laid off, the teaching force will continue to age, and few talented young people will choose teaching as a career. Educators and educational leaders will still have to face these serious problems.

Since computers play a supplementary role, they worsen budget problems. Even if the computers are donated to the schools, people must be trained to use them, and software must be created or purchased. Other than that, studies (Lockheed & Frakt, 1984; Anderson, Welch & Harris, 1984; Watt, 1984a; Schubert, 1984; Alvarado, 1984; Lautenberg, 1984) have found inequitable access and use, and careless use of computers in schools. These inequity problems become a new burden for today's educators.

Problems of computer uses in education

Software problem   Computers are widespread in education, not only in formal schools, primary, secondary, and university, but also in training, adult education, and in homes.

Accordingly, by April 1984 U.S. schools had approximately 350,000 computers available to students in grades one through 12--an average of about four computers per school. The number of computers in the schools has roughly doubled each year and will continue to increase rapidly

(Bork, 1984a). Talmis, Inc., a market research group, estimates that the parents of one out of six school-age children have already purchased a computer for their child's use at home; that is, about five million computers are in the homes of U. S. families with children (Komoski, 1984). There will be a tremendous demand for educational software in the near future.

Based on current market information (including business and industry), Booz, Allen, & Hemilton Inc. (1984), forecast the personal computer software market to be nine billion in 1994, which is 4.5 times that of 1983. Among those, five billion are home market; only 0.48 billion belong to education. However, the demands of educational software for schools and homes are sizeable.

Looking back to the currently available educational software, 60% of the programs were rated as "not recommended" or "not considered"; only five percent of the programs have been highly recommended by Educational Products Information Exchange (EPIE) Institute which is a consumer-supported evaluation agency associated with the Consumer Union (Komoski, 1984). A database was set up in 1982 by the EPIE project to provide consumers with reliable information on what software is available, what software has been taken off the market, what each program is designed to do, how much it costs, what hardware it runs on, whether it can be networked, whether it has been evaluated, and whether it is recommended for purchase.

Bork (1984a) listed thirteen factors which characterize poorly designed educational software:

1. failure to make use of the interactive capabilities of the computer;
2. failure to make use of the capabilities of the computer to individualize instruction;
3. use of extremely weak forms of interaction, such as multiple-choice questions;
4. too-heavy reliance on text;
5. too-heavy reliance on pictures, when these pictures play no important role in helping students learn the material;
6. treatment of the computer screen as though it were a book page;
7. use of material that is entertaining or attractive but that is only vaguely educational;
8. content that does not fit anywhere in the curriculum;
9. focus on games that have no educational merit;
10. use of long sets of instructions at the beginning of programs that are difficult to follow--even for teachers-- and difficult to recall;
11. heavy dependence on auxiliary print materials;
12. presentation of segments of content that are not placed in context; and
13. use of materials that fail to hold students' attention.

It is important to keep in mind that the quality of educational computing depends on the quality of the software selected and, more important, on whether that software is integrated into the overall curriculum. How does an educator effectively exercise the new role as an evaluator of software? Caissy (1984) presented a handy list of guidelines which are especially helpful for those who have a limited knowledge of computers and a limited acquaintance with available software programs.

The following four general questions are considered first:

1. For what purposes will the software program be used?
2. Who will be using the program, in terms of grade level, age, or ability level?
3. What are the objectives of the program?
4. What knowledge or skills must a student possess in order to use the software program successfully?

Once these four general questions have been answered the following nine specific elements of instructional design are focused on next:

1. Is the program making full use of the technology of the computer?
2. Is the program likely to motivate and interest youngsters in the target audience?
3. Who is in control of the program, the student or the computer?

4. Is the ability level suitable for learners who will use the program?
5. Is the instructional design sound?
6. Are the instructions in the program clear to students?
7. Is the reinforcement appropriate?
8. Does the program provide a record of student progress?
9. Is the program grammatically sound and free of unnecessary computer jargon and spelling errors?

The following four questions cover other concerns that also need to be examined:

1. Are the screen layout and design suitable?
2. What is the life expectancy of the program?
3. Is the command code that loads and runs the program both simple and clearly displayed in the instructions that are packaged with the program?
4. Are the operating instructions and teaching manual helpful?

In summary, interactivity, individualization, documentation, integration into curriculum and attractiveness are the essential elements of a quality software. More important, a quality software is merely a tool to facilitate teaching and learning activities.

It is clear that the software problems will become the major issue of quality computer education. The fundamental problem is a shortage of quality educational software, but there are some other aspects needed to be considered.

<u>Developing support</u> The development of software is costly and time-consuming. The best estimates of the time required to design and code a computer program range from 100 to 300 hours per hour of running time. This does not include the time needed to think up the program ideas. This translates into a development cost, for a program that students might use for one hour, of between $2,000 and $10,000, depending on its sophistication and complexity (Walker, 1984).

By contrast, to produce text material to occupy a student for an hour is a matter of a few hundred dollars at most. It is impossible for an individual to use his/her spare time to develop a high-quality software. A team including classroom teachers, programmers, and instructional designers with long-term financial support are the best approach.

<u>Machine incompatibility</u> Microcomputers are popular in today's schools and homes. There are thousands of software on the market. However, most of them are machine/language dependent and probably without any documentation. Although manufacturers put their effort in developing an interchangeability between different microcomputer operating systems, a "standard" has not been developed. The incompatibility of software packages will limit the purchase and selection of high-quality learning material.

<u>Software piracy</u> Many software producers are reluctant to invest in the development of products that possibly will be copied by customers. Thus, most of software companies today refuse to grant

previewing privileges, because they fear their software will be illegally copied and then returned to them unpurchased. This increases the difficulty of purchasing a quality software. If the illegal copying of educational software continues, the price necessary to recover the investment must be high. This obviously makes it prohibitively expensive for a school to buy enough copies to supply one for each computer. Therefore, software will only be used as a supplement, or it will continue to be illegally copied.

Integration into the classroom   Even a well-designed piece of software will not fit exactly into a given teacher's plans. Adjustments must be made to accommodate it. If the software is not modifiable, then all the adjustments must be made elsewhere, and there are limits to a teacher's willingness to tailor everything else to one program. And when a teacher uses several programs in the course of a year, each of which requires a different set of adjustments, the program may become unworkable.

Competition for the home market   The number of installed computers in homes far exceeds the number in schools, at a ratio of about 10 to 1 (Komoski, 1984). Software manufacturers can therefore sell to a larger market by producing for the home. And most of them do. This means that software is designed primarily for conditions in the home--one student per computer, unsupervised use, and episodic use with little extended continuity in the development of skills and ideas.

Rare field-testing of the software   The EPIE reported in April 1984, that only about one out of every five software programs had been learner-tested by its manufacturer during its development. Six months later the figure still holds. The lack of field-testing, in addition to the lack of previewing, will increase the difficulty of selecting a quality software.

Inequity problem   The issue of inequity and computers is receiving increasing attention. Educators who were reluctant to notice any inequities just a short time ago now look for remedies to combat inequitable practices related to computer access and use. Recent studies have revealed several dimensions to the issue:

Inequity and economics   Wealthier communities tend to have more microcomputers in schools than do poor communities; middle to upper income homes have a higher proportion of home computers than lower income homes; students from higher income homes more often attend computer camps or private computer classes (Schubert, 1984).

Inequity and community size   There were not any substantial differences in school computer utilization when students who lived in different-sized towns and cities in a Minnesota study were compared. However, smaller communities do not provide as many opportunities for computer education as do larger communities. The same results were found in suburban and rural schools; there are more students in computer courses in suburban schools (Anderson, Welch & Harris, 1984).

Inequity and region Students who live in the Southern part of the U.S. are less likely to use computers than their counterparts in the Central, North, and West regions (Anderson, Welch & Harris, 1984).

Inequity and intellect The "brightest and best" sharpen their intellectual skills by problem-solving and programming, while the less gifted students are drilled in the three R's (Becker, 1983a).

Inequity and implementors In schools where groups of teachers or administrators share implementation responsibility, there is more parity in microcomputer use by above and below average students than in schools where a single teacher is the lead implementor (Becker, 1984c).

Inequity and funding Schools that purchase microcomputers with federal grant money have less flexibility in how computers are used (typically to teach basic skills and drill an practice) than do schools with private sources for computer purchase with "no strings attached" (Schubert, 1984).

Inequity and ethnicity Schools with a larger percentage of minority students have fewer computers than racially mixed or all-white schools (Schubert, 1984); however, there is no significant differences were reported between black and white students for both males and females on computer exposure (Anderson, Welch, & Harris, 1984).

Inequity and gender There is no sex difference in sixth-grade students' self-confidence regarding computers, in the students' perceptions of the utility of computers, or in their attitudes toward computers. However, males have greater access to computers than do females and use them more. All these indicate that if males are gaining an edge in computer technology, it is not due to sex differences in interest toward or understanding of the relevance of computers; but to sex differences in access to and use of computers (Lockheed & Frakt, 1984). What factors account for this difference in computer use and access? Sex segregation, social context of computing, costs of learning, and quality and relevance of the computer curriculum are some possible answers.

1. Sex Segregation. Researchers have demonstrated repeatedly that boys and girls in grades K-8 typically lead highly sex segregated lives, and that this segregation persists into secondary school for most activities. Even if girls are interested in using computers, pre-existing habits of sex segregation can inhibit their desires. If the boys go to the computer center, then the girls may decline to enter there. By male self selection and female default, the computer center becomes defined as "male turf."
2. Social Context of Computing. One recent study of illustrations in advertisements and articles in three major computer magazines found that 69 percent of the illustrations depicted only men or boys as computer users and only 13 percent featured only girls or women. Moreover, the titles of computer games and software are usually directed to a male audience. When junior high school students were asked to evaluate the titles of 75 randomly selected pieces of

software for gender orientation, the students rated nearly 40 percent of the titles as written primarily for males and only five percent of interest to females. Another aspect of the context of computing is the association between computing and mathematics. Although there is no evidence to show the close relationship between learning computers and mathematics, too often computing courses are offered by teachers of mathematics, in conjunction with mathematics courses. Thus some math anxious students, especially female students, become computer-anxious even without trying computers.

3. Costs of Learning. It appears that parents are more willing to invest in a home computer and computer training for their sons than for their daughters. Even in one high income district, a survey in 1982 reported twice as many boys as girls having computers at home. A survey of computer camps found that male enrollment outnumbered female enrollment three to one, and that the more expensive the camp, the lower the female enrollment (Lockheed & Frakt, 1984).

4. Quality and Relevance of the Computer Curriculum. Studies show that girls find little immediate practical use of simple programming skills and would rather learn applications programs for word processing, database use or graphics. Regarding the interest in further computer-related courses, the majority (52%) of the girls indicated an interest in word processing or business/research applications, whereas the majority (59.4%) of the boys indicated an interest in additional training in programming languages. The same

study also showed that fewer girls than boys liked working with computers, learning to program, or writing programs to solve.

A National Assessment in Science examined the trend (from 1978 to 1982) of computer education opportunities nationwide. In 1978, seven percent of students in Title I schools and 11% in other schools had taken computer program classes (Schools qualify for Title I assistance by having a large percentage of parents with income below the poverty line); in 1982 still only seven percent of Title I Schools students were enrolled, but 14% of students in other schools were enrolled in computer courses. Little growth is seen in suburban and rural school students in the enrollment of computer courses from 1978 to 1982, but differences exist. The growth in suburban schools was 17% but only six percent in rural schools. Small cities schools student enrollment increased rapidly from 1978 to 1982, while there was a little growth in big city schools. In 1982, enrollments were the same between big and small city schools. Females (8%) were less likely to take computer courses than males (14%). The difference remained consistent from 1978 to 1982.

The Computer Education Assistance Act by Senator Lautenberg was introduced in 1984 to improve the equity in computer education. This legislation would provide federal matching grants to schools to be used for computer education programs. The formula for distributing the funds among the states is based half on the number of school-aged children and half on the number of poverty-level children. Within each state, half the funds are to go to schools with poor children. While providing assistance for all schools, this legislation would concentrate resources on the less well-off schools which have the greatest need.

Computer crimes in schools Often the introduction of computers creates a problem of security and confidentiality, and gives ample opportunities for computer crimes. As schools becomes more computerized they should tackle the computer crimes problem, thus reducing the dangers to a minimum. Five main types of computer crimes probably be identified in schools:

Hardware sabotage This is a simple, primitive type of crime which does not necessitate either knowledge or sophistication.

Property theft There are two types of property theft: (1) the actual theft of hardware parts such as floppy disks, diskettes, terminals and computer paper. (2) software theft, i.e., administrative, CAI and CMI programs.

Services theft This is the use of the computer for unauthorized purposes. This new type of crime might increase in the school which, being a small organization, lacks supervisory computer experts. In this setting, the sophisticated user might easily use the computer for his/her private purposes, without anyone being aware of it.

Theft of information Many businesses will be interested in the information contained in the master files of students, personnel, etc., in order to increase their sales. Master files do not even have to be removed from the premises; they can be copied without anyone knowing. Huge volumes of information can be retrieved in minutes by the criminal who has access to it.

Embezzlement and fraud Embezzlement is mostly possible in the administrative processing area, such as finance, personnel, student data grades, etc. Examples in the input process, are either by withholding or changing data in the source document; in the update process by unauthorized access to the programs/computer/master files; or in the output process by stealing a copy of a report, copy data from reports and their sale, etc.

To protect the school's administrative and instructional system against computer crimes, the proper use and safeguarding of educational and administrative data, and the effective use of computer hardware and software in the schools are areas of important concern (Telem, 1984).

Promising computer applications

What will be the future uses of computers? As technology advances and costs reduce, the computer will likely become a household item as common as a refrigerator or an oven. Whether we are ready or not, computer-controlled devices will influence all of our lives. It is clear that individuals, as well as society, need to make major adjustments as computer uses and applications become more widespread. Research and development is geared toward four areas of advancements in computers: continued miniaturization, greater memory capacity, speech synthesis and recognition, and enhanced graphic displays. It is very difficult to predict the future advances and applications of computers. Some promising applications are described in the following:

Database   A database is a systematic way of storing data files for further processing. A typical database contains files that can be used to perform any number of specific functions-- search for, arrange, analyze, display, or print data much faster and more accurately than we ever could. The database management system is a comprehensive software system that builds, maintains, and provides access to a database. A good management system has the capability of being cross referenced according to the information within each file. The Internal Revenue Service and The National Crime Information Center carry a huge database for individual information.

Large computers have handled database for a number of years. However, an attempt is being made to put databases on microcomputers. With the advent of chips that accommodate large amounts of data, databases on microcomputers will become a reality. Microcomputers can also access databases through a modem and telephone. The microcomputer becomes an intelligent terminal for the accessing of the information from a database. We can then have immediate access to accurate and constantly updated information.

Word processing   Word processing refers to manipulating and storing textual material in a computerized medium. It allows written communication of all sorts to be easily generated, proofread, printed and revised. In using a word processor, texts such as business letters are entered by means of a typewriterlike keyboard and a TV screen displays each character as it is typed.

The word processing is fairly easy to edit, to change the format, to check the spelling, to store and retrieve the text, and to duplicate as many copies as possible. Actually, the application of word processing has improved the quality of writing and saved human labor to produce neat, final prints. The use of the word processor in schools can greatly add to the productivity and the quality of students' writing.

Robotics A robot is a self-contained, teachable, programmed-controlled manipulator. Microprocessor chips and all moving parts which are needed to operate a robot are contained within the robot itself. Most robots can perform only one task repeatedly; even with added accessories, their functions are limited to those specific capabilities manufactured into them. With teachable robots, however, functions can be altered (with a basic range, such as picking up, putting down, or following a path). Changes can be made as desired and as needed. Usually a computer program tells a robot what must be done. And being a manipulator, the robot can perform functions with objects.

Why have robots become so important, especially in industry? Being a machine, the robots are able to work twenty-four hours a day, seven days a week without sick leave, and do not become irritated with the boss (although they do occasionally malfunction). Furthermore, robots can work in dangerous places where humans cannot work and can perform tasks that humans either cannot do, or do so slowly, that costs in time and money make their work unprofitable.

The future of robots is mind-boggling. Robots will continue to replace humans in repetitious, dangerous, menial, and boring tasks. As the cost of robots decreases, they will become more common in industry and perhaps even in the schools and homes. Their potential is limitless.

Artificial intelligence Artificial intelligence refers to devices that possess cognitive ability: reasoning, learning, remembering, inferring, and thinking, similar to those of the human mind. It is expected that by 1990, the fifth-generation computers with artificial intelligence capable of decoding instructions given in ordinary human language, will become available. The artificial intelligence computers may be able to compile their own instructions to perform virtually any task they are asked to perform.

The impact of AI computers in the schools will be momentous. Very young children will be able to operate computers without the need for typing skills or knowledge of programming languages. They will be able to "teach" the computer to carry out the activities they want done. Since the AI computer functions as intelligent aids to their users, rather than as merely programmable machines, computers will become more effective teachers, listening to students, responding according to information sorted in memory, and then storing information for later use.

Data communication Data communications involves electronically transferring data from one point to another without altering the data as it travels. Several methods of data communications are in the development stage. The currently popular method uses telephone lines--a modem converts binary signals in the computer to voice-like waves that travel over telephone lines.

Three types of transmission may possibly serve in data communications. Simplex represents a one direction only via a data communications link. Half-duplex is an alternating data transmission in two directions, but occurs in only one direction at a time, and is the most widely used system. Full-duplex is a system in which data can be transferred in two directions simultaneously. A network data communication system will provide the most benefit to remote learning in the future. The system will improve the equality of educational access and enhance the effectiveness of remote instruction.

Computer in tomorrow's education

It seems certain that the numbers of computers in schools, and thus the student's access to computers, will continue to increase. Two major issues assure this: (1) the effectiveness of computer in education; and (2) the economics of the computer in education. The effectiveness comes primarily from interaction and individualization. The economic issues are even more obvious. It is a trend for (1) commercial companies to step up their efforts to produce and distribute increasing quantity and quality of computer-based learning materials; and (2) computers to continue to evolve and improve, and their price continue to reduce. Computer graphics capability will increase, and more of them will offer choices in type fonts and sizes. It is also expected that there will be larger screens and better resolution of the images on those screens. In the not-too-distant future, videodisc technology will come into wider use. Furthermore, such features as voice, even brainwave, input to become practical as well.

One major outcome of the implementation of computers in education will be a large-scale development of curricular materials that make an integral part of learning possible from first grade through college. The new computer-based learning materials must incorporate a wide range of learning theories and approaches to insure that the educational system becomes more diverse and pluralistic than ever before. The new courseware will lead to changes in organization of schools and to a new and more dignified role for teachers. It will free instructors from conducting routine drill and performing management duties and give them more time to be the vital human link between students and knowledge. Many activities that currently take place in the school will shift to the home, the public library, and other environments, since computer-based learning can take place almost anywhere. But some learning activities particularly those are best be done in groups will continue to take place in the school.

Willis (1984) described in more detail the major changes in education in the computer era.

1. A smaller percentage of courses on computing will be programming courses. Instead, the emphasis will be on literacy courses, in which

the concepts of computing and the societal implications of the computer will be emphasized. Courses also will place greater emphasis on learning to use applications programs rather than programming. Instead of learning to write programs in BASIC, students will learn to use database management programs, word processors, electronic spreadsheet software, and telecommunications.

2. The computer will play a central role in the curriculum. The computer will be a significant element in an educational technology that provides drill and practice on basic academic skills, tutors students on a wide range of topics, and provides students with simulated experiences doing everything from running a nuclear power plant to taking a trip around the solar system. The computer will become an important, even essential, tool for accomplishing educational goals. But for more advanced academic areas, classroom discussion and group interactions will still be the major learning approaches.
3. As the American school system accepts the computer and begins to use it, that system will also undergo major changes. The public school system will play a smaller role in society than it does today. Education will be a lifelong task for most citizens; and learning will increasingly become a regular part of life in the home, the office, and the factory. The computer will play an even larger role in this expanded educational system than it does in the traditional system.

4. The development of other, important learning systems will create new and different career paths for professionals who are trained educators. Increasingly, educators will be lured from public school classrooms to jobs in other sectors of the economy. If there is significant competition between the business community and the public education system for talented educators, it is quite possible that the public education system will become a second-rate, second-class system that becomes virtually impotent in an era when it is needed most.

Let us now imagine in the year 2000--

> It is no longer necessary to attend most of the classes on a school campus. Students use their home computers to assist the learning, they need only to dial up school codes to contact teachers who are available at certain hours to discuss assignments and give help. Prerecorded lessons are presented on the home computer screen. Then, a videotape of the teacher's presentation further illustrates the key points made in the lesson. The course materials also include programmed learning materials that the computer uses to analyze a student's answers to questions, provide remedial work, suggest additional sources of information, accelerate the pace at which material is presented, administer exams,and so on. Students work at their own pace but must complete a series of lessons within a given period of time. Students can register for courses with noted experts in different schools in the same semester, without having to travel to the campus.
>
> Information retrieval is vastly different from the way we know it today. Instead of being filled with shelves and shelves of books, libraries now have huge computer memory banks that can be accessed by anyone. Books and other sources of information have been entered into computer memory for easy access at any time. Even archives of the earliest books can be called upon for reading or research. With this system, the reader can see an entire book or article, or selected portions of it. The video screen shows pages one at a time. Photos can also be examined. Certain books can be printed out and added to one's personal home library. For the latest published information, magazine articles can be accessed through an on-line information system to obtain directly from

the publishers to show on the computer screen or get hard copy output immediately.

As a result of using computers in education, (1) learning will become more individualized and active; (2) learning will take place anywhere; (3) network system will become popular; (4) institutions will change in nature; and (5) in the future more people will have the access to education and learn more efficiently and successfully. But whether the quality of education will be improved or not depends completely on the design of the new curriculum--a systematically computer-supported learning model from first grade through college including all of the subject areas which are taught in today's schools.

CHAPTER III METHODOLOGY

The primary purposes of this study were to develop and validate a computer anxiety instrument for general use and to better understand the nature and occurrence of computer anxiety. Theoretical model, population and samples, instrument design, data collections, and methods for analysis are included and discussed.

Theoretical Model

Computer anxiety was defined in this study as a negative attitude or behavior by an individual when considering the application of utilizing computers, or when actually using computers. The result of anxiety is a sequence of cognitive, affective, physiological and behavioral events that may be initiated by a stressful external stimulus, or by an internal cue that is perceived or interpreted as dangerous or threatening by an individual. On the whole, anxiety appears to be fairly complex human reactions which manifest changes in an individual's perception, emotion, and performance.

A theoretical model, with four major domains which presumed to include all events reflected to a stressful stimulus (computer), was applied initially to develop the items. Four tentative domains were defined as follow:

1. Cognitive domain--refers to an individual's perception, understanding, and appraisal of computers. The reactions are reasoning and not emotional, usually a thinking or evaluation process has occurred.
2. Affective domain--refers to an individual's subjective emotional reactions toward computers. The reactions are direct and immediate and do not include any mental process.
3. Physiological domain--refers to an individual's subconcious reactions toward computers. The reactions which are physically manifested are extracted by the autonomic nervous system and tend not to be controlled consciously.
4. Behavioral domain--refers to an individual's performance with computers. The performance is the effect of cognitive, affective, and other internal or external impacts during the anxiety arousal process. The effect reveals the intensity of computer anxiety.

Population and Samples

Based on the findings of Lockheed and Frakt (1984) that "There is no difference in sixth-grade students' self-confidence regarding computers, in the students' perceptions of the utility of computers, or in their attitudes toward computers..."; and concerning the application of a paper-pencil self-report survey method, the population of this study was determined to include individuals over twelve years of age.

Samples participating in the study were not randomly selected from the population or representative of the population. For obtaining sufficient samples, maximizing the sample variance, and ease in manipulation, the researcher planned to collect 1,000 usable data forms from four major student groups--high school, 2-year community college, 4-year college/university, and graduate school. It was expected that the participants, although volunteers, would be diverse in terms of educational level, age, gender, major, computer courses taken, computer experience, and school learning environment.

Instrument Design

Demographic information

One of the purposes of this study was to understand the nature and occurrence of computer anxiety. It was found that the intensity of anxiety was related to an individual's experiences and characteristics. The following personal categories were highlighted to develop appropriate demographic questions.

1. age
2. educational level
3. gender
4. major/intended major
5. computer courses taken
6. computer experience

7. ownership of personal computer
8. interest in math and overall math grade/ability
9. belief of sex-equality in relation to computers
10. parents' occupations and attitude toward computers
11. school environment for learning computers
12. general trait-anxiety

Twenty-nine personal background questions including nine of the general trait-anxiety items were developed.

Computer anxiety instrument (version I)

An item bank consisting of more than 300 items was developed from the following resources: Taylor Scale of Manifest Anxiety, Spielberger's State & Trait Anxiety Inventory, Rohner's Educational Innovation Survey and Computer Attitude Questionnaire, Miller's Tool Anxiety Scales, Fennema-Sherman's Mathematics Attitude Scale, Parsons' Teaching Anxiety Scale, Lichtman's Educator's Attitude toward Computers Items, Ahl's Public Attitudes toward Computers Items, Ellsworth's Beliefs about Computers and Using Microcomputers for Instruction Items, and Suinn Test Anxiety Behavior Scale (STABS).

A content analysis was conducted to balance the number of items within each domain. Ninety-one items were selected and classified under three headings: (1) Feelings or Reactions toward Using or Learning Computers, which included 57 items, with 17 items designed for those who had hands-on computer experiences; (2) Beliefs about Computers, which included 23 items; and (3) Reasons for Not Using Computers, which included 11 items. The demographic section, which included 29 questions was added to compose a primary paper-pencil computer anxiety instrument (see Appendix A). A five-point rating scale defined by the labels, strongly agree, agree, uncertain, disagree, strongly disagree was employed to allow more choices of responses between absolutely agree and disagree.

Computer anxiety instrument (version II)

Fourteen faculty members who represented the areas of Industrial Education & Technology, Sociology, Educational Research, Educational Technology, Educational Computing, Psychology, Statistics/Psychology, and Computer Science at Iowa State University were invited to examine the appropriateness and plausibility of items and rate the potential computer anxiety level of each item.

Seventy items were rated as "appropriate" by at least two-thirds of the examiners. Few items were modified or reworded to eliminate the possibility of misunderstanding. Five new items asking about the reasons for not using computers were added in Part III.

Suggestions from the examiners included (1) moving the demographic section to the beginning of the instrument, (2) adding appropriate headings, (3) modifying the directions, and (4) changing the format for machine scoring.

The instrument was revised to apply a computer answer sheet for machine scoring. Following is the major structure of the version II instrument.

Directions (in general)

Part I. Background information

(a) About yourself (11 items)

Trait-anxiety (9 items)

(b) About your parents and school (9 items)

Part II. Feelings or reactions toward the learning or use of computers

(a) Anxiety items in general (23 items)

(b) Anxiety items for experienced computer users (16 items)

Part III. Attitude toward computers (20 items)

Part IV. Reasons for not using computers (16 items)

One open-end question for additional reasons for not using computers

A question about the font used in the instrument.

Return address

Acknowledgement

The version II instrument was then used for the item scale value construction and a pilot study.

Data Collection

Three sets of data were collected for the purposes of item scale value construction, pilot study, and field test.

Item scale value construction

A special format with a judges' directions section attached on the right side of version II instrument (see Appendix B) was used to construct the item scale value. The form was specially designed for the judges to easily assign the rating scale value to each item.

Forty Iowa State University graduate students were invited to be judges for scaling the items. They were volunteers. Out of the 40, 17 were females and 23 were males. Their areas of study included: Educational Computing (19), Statistics (6), Physics (4), Computer Science (5), Economics (2), and Industrial Educational & Technology (4). In addition, nine valid responses obtained from the previous appropriateness examinations procedures of faculty members were included. There were 30 males and 19 females in total. Most of the data were collected individually. Only twenty rating sheets (including 19 graduates and one faculty) were collected from an educational computing class (Computer Supported Learning 558). Forty-nine usable ratings were used for the analysis.

Pilot study

A pilot study was conducted for the tryout of the preliminary instrument. Ideally, participants of a pilot study would be representatives of the population. Because of the limitations of time schedule and cost, data were collected half from one computer programming class (PASCAL 175) and half from four introduction to education classes (Foundation of American Education 204). There were 102 students in the PASCAL class and 148 in the educational classes. Most of the participants were freshmen or sophomores.

The pilot study instruments (Appendix C), which had part of the responses on a separate computer answer sheet, were distributed to the students in the classroom meeting by the researcher. A brief introduction about the purposes of the study, the contributions for the pilot study, and directions for responding, were presented to the class before they began to respond to the items. Two classes answered the instruments during the class period. Others took the instruments home and brought it back at the next class meeting. One hundred and eighteen data forms were obtained, which included 25 from the programming class (most were majors in business or related areas), and 93 from the educational classes (all majors in education related areas). Among the returns were 49 males, 68 females, and one respondent of unknown gender.

Field test

The researcher planned to obtain one thousand usable data forms from four educational levels of students. An invitation letter (see Appendix D) explaining the purposes of study, the significant applications of the findings, the peculiarities of samples needed, and a sample copy of the instrument were sent to the principals or instructors of several Iowa high schools, community colleges, and some out-of-state universities to request the willingness to participate in the study. The schools and universities utilized were those recommended by faculty members who knew resource persons in a particular school or university. Four high schools, three community colleges and five universities showed an interest in the computer anxiety study.

The number and the peculiarities of samples were arranged in advance by a contact person, at the request of the researcher. Instruments were sent to the contact person with a letter (see Appendix E), a instruction of procedure (see Appendix F), a cover letter for participants (see Appendix G), and a business reply label.

The field test instruments (Appendix H) were distributed to the students in the selected classes by their instructors. Scheduled class time was used for completing the instruments in most cases. Some were collected at times other than class periods. For those who completed during the class period, a nearly 100% return was reached. Data forms were returned by the contact persons as the collection procedure was completed.

In addition, 212 graduates including 103 from one statistics class and 109 from eight educational classes at Iowa State University were included in the field test (see samples of field test in Appendix I). For most of the classes, a presentation was given before distributing the instruments. Data forms were collected by instructors or the researcher in the classes, or returned by mail. In total, 1,454 students volunteered for the study, 999 (69%) returned their questionnaires.

Methods of Analysis

Two statistical packages, SAS and SPSS, which are installed in the IBM AS/9160 mainframe computers at Iowa State University, and a microcomputer statistical package for Northstar microcomputer were used in this analysis procedure:

1. Educational Statistics Package for Northstar Microcomputers (ESP) by William G. Miller, Iowa State University;
2. Statistical Analysis System (SAS) by SAS Institute Inc.; and
3. Statistical Package for the Social Science (SPSS-X version) by SPSS Inc.

<u>Item scale construction</u>

A descriptive analysis was applied to examine the distribution of the responses for each item and the characteristics of samples. Means, standard deviation, skewness, and frequency were examined. A successive interval scale method was then used to obtain the scale value and discriminal dispersion of every item. Difference between judge groups were verified by a T-test. Male versus female, graduate students versus faculty members, and educational computing majors versus others were compared in terms of the item scale value and item mean.

<u>Instrument validation</u>

A descriptive analysis was used to examine the distribution of responses including mean, frequency, and correlation matrix for all variables. Factor analysis was applied to check the theoretical domain of the instrument and obtain the factor loading of items. Item-total Pearson product-moment correlation coefficient as well as factor loading were used as criteria to select the appropriate items. A reliability analysis was employed to determine the instrument internal consistency. Reliability coefficients of subsections and the whole instrument were calculated.

Variables contributing to computer anxiety

A correlation matrix was calculated to examine the collinearity of initiated variables of computer anxiety in this study. Analysis of variance and multiple-regression analysis methods were then used to identify the significant variables which contributed to the variance of computer anxiety. A frequency analysis was conducted in a non-computer-user group to determine the the major reasons for not learning or using computers.

CHAPTER IV RESULTS AND FINDINGS

This chapter includes three parts of the analysis results: item scale value construction, pilot study, and field test.

Item Scale Value Construction

The instrument of this study was primarily designed using the successive interval scaling method. It was assumed that computer anxiety could be attributed to a characteristic that exists in differing degrees in different persons, and item values are distributed unequally on the computer anxiety continuum and indicate diverse levels of anxiety.

As described previously, 49 faculty members and graduate students were invited, as judges, to estimate the item scale values. Table 1 describes the characteristics of the judges.

The item's mean, standard deviation, skewness, and frequency of responses were examined. It was found that the judge's rating skewed positively or negatively for most of the items, based on the nature of the particular item. Appendix J includes the specific details.

The successive scale value of each item was calculated with the aid of a microcomputer educational statistics package (ESP revised by Miller, 1983) through the Northstar computer. The results revealed that scale values were almost dichotomized with fairly large discriminal dispersions, but not distributed continuously as expected (see the last

TABLE 1. The Characteristics of Judges

Characteristics	N	Percentage
Sex		
Female	19	38.8
Male	30	61.2
	------	--------
Total	49	100.0
Occupation		
Faculty	9	18.4
Graduate Students	40	81.6
	------	--------
Total	49	100.0
Major		
Educational Computing	19	38.8
Others	30	61.2
	------	--------
Total	49	100.0

two columns of Appendix J). This distribution occurred probably because (1) the items were highly skewed, which did not correspond to the normality assumption of successive interval, and (2) the items were originally designed to differentiate between high and low anxiety persons. In other words, items tended to be either positive or negative in nature. By examining the table of item means, only one item's mean was in the range of 2.50 to 3.50, which could be considered as a neutral value. This result also supported the dichotomy characteristics of items (see Appendix J).

From the findings of non-normality of item distribution, it was decided that the Likert scale should be adopted and replace the successive interval scale. By the application of the Likert scale, the item's mean was used as an index to classify items into three categories: negative, neutral, or positive. Items with a mean value of above 3.00 were considered as high anxiety items, those with a mean below 3.00 were considered as low anxiety items. With the first 59 items, 28 were classified into the positive (low anxiety) category, and 31 were classified into the negative (high anxiety) category. The other 16 items asking "the reason for not using or learning computers" were not included in the item classification procedure.

For instrument scoring, a 1 to 5 scale value was assigned to the selections of strongly agree to strongly disagree. Scoring was reversed for those high anxiety items. An individual's primary anxiety level was calculated by averaging response values across all the completed items. The higher the score, the higher the computer anxiety a person possessed.

T-tests were also conducted to test the equality of item means of the judge groups. Females versus males, graduate students versus faculty members, educational computing majors versus other majors were compared. No difference was found between educational computing majors and other majors. Differences were found between male and female groups and between faculty members and graduate student groups for certain items. Significant results which were tested at the 95% confidence interval level are displayed in Table 2.

TABLE 2. Item Mean Difference

Item	Group	N	Mean	T Value
Male vs Female				
11 I (would) enjoy having a home computer.	M F	30 19	1.93 2.84	-2.24*
17 If given an opportunity, I would like to use and learn about computers.	M F	28 19	1.75 2.42	-2.03*
18 I (will) avoid certain classes/jobs because of the use of computers.	M F	30 19	4.57 3.68	2.70*
Faculty vs Student				
1 I usually have been at ease during occasions when computers were involved.	Fa Su	9 40	1.22 1.88	2.81**
2 I get a sinking feeling when I think that, no matter what, I have to learn/use computers.	Fa Su	8 40	4.88 4.15	-3.21**
8 I feel confident about my ability to deal with computers.	Fa Su	9 40	1.22 1.95	3.22**
9 I am (will be) proud of knowing how to use computers.	Fa Su	9 39	1.44 2.54	4.06***
10 I am not the type of person who does well with computers.	Fa Su	8 40	4.25 3.58	-2.82**

* :Significant at 0.05 level.
** :Significant at 0.01 level.
***:Significant at 0.001 level.

TABLE 2 (continued)

Item	Group	N	Mean	T Value
11 I (would) enjoy having a home computer.	Fa Su	9 40	1.78 2.40	2.16*
14 I feel apprehensive about using a computer.	Fa Su	9 38	4.44 3.63	-3.01**
15 Computers make me feel so stupid.	Fa Su	9 39	4.78 4.10	-2.66*
20 If available, I would choose computer related work over other possibilities as my future job.	Fa Su	8 40	1.23 2.08	3.73***
22 I am looking forward to the time when computers are in all homes.	Fa Su	8 40	1.38 2.00	2.44*
30 Once I start to work with a computer, I find it hard to stop.	Fa Su	9 37	1.00 1.73	3.65***
32 When I get into a computer problem that I can not figure out immediately, I stick with it until I have the solution.	Fa Su	8 38	1.38 2.05	2.50*
34 I enjoy the challenge of figuring out how a computer program works.	Fa Su	9 38	1.11 1.92	3.85***
35 Computers make me feel as though I am lost in a jungle of "commands" and cannot find my way out.	Fa Su	8 38	4.50 3.82	-2.59*

TABLE 2 (continued)

Item	Group	N	Mean	T Value
36 Sometimes my mind goes blank, and I am unable to think clearly when working with computers.	Fa Su	8 38	4.75 3.81	-2.96*
37 I enjoy showing someone else how to use a computer.	Fa Su	9 38	1.11 1.87	3.67***
38 I feel calm and collected even when the computer gives me a lot of error messages.	Fa Su	8 38	1.25 1.79	2.21*

1: Low anxiety   M: Male   Fa: Faculty
5: High anxiety   F: Female   Su: Student

By examining the mean values in Table 2, male and faculty member groups tended to rate the scale value more extremely than female and student groups. This was also true for the rest of the non-significant items for faculty member versus student comparison groups, but not for the male versus female groups. Even though the ratings were different between some judge groups, all the groups tended to classify the items consistently.

Pilot Study

The main purpose of the pilot study was to try out the instrument before it was field tested. The following information was obtained from the tryout:

1. The clearness of item statements and instructions.
2. The time needed to complete the instrument.
3. The appropriate method for instrument distribution and data collection.
4. Item response pattern and item discrimination.
5. The validity and reliability of the instrument.
6. General reactions to the instrument.

Two hundred and fifty undergraduate students, 102 from a PASCAL programming class and 148 from four Foundation of American Education classes, participated in the pilot study. They were selected on the basis of their diverse computer experiences and for the convenience of data collection. Ideally, the pilot group should have been randomly selected from the population to avoid distortion by the peculiarities of the groups. In this pilot study, conclusions should be drawn cautiously because a homogeneous group was used.

The characteristics of the pilot study participants are displayed in Appendix K. About 40 percent of the pilot study samples were females, and most of the participants (86.4%) were 18 to 21 years old. Half of the samples were education majors or in related fields, none of them were majors in computer related areas. Among the group, 26 (22%) did not have any computer-related experience, and 49 (41.5%) had never had hands-on computer experience other than playing computer games. About one third had taken introductory computer (28.8%) or programming classes(30.5%). In summary, these participants represented a computer novice group who would be more sensitive to computer anxiety than experienced users of computers.

Results

1. Item response-patterns were examined to determine the items which apparently reflected agreement or disagreement by most of the respondents. It was assumed that those apparent items with response distributions highly skewed tended not to discriminate between low versus high anxiety persons. Twelve items with a skewness value greater than absolute 1.00 were identified. Table 3 lists the items.

2. Item redundancy was checked by inter-item correlation coefficients. A Pearson Product-moment correlation matrix was examined. The coefficient values ranged from -0.42 to 0.73. Few items were correlated above the value of 0.65. Table 4 contains the highly correlated items.

Although items listed on Table 4 were correlated highly in comparison with the rest of the items, none of them were discarded. This decision was made because there is a tendency for a homogeneous group, which contains limited individual variety in nature, to have higher inter-item correlations.

3. Factor analysis was conducted to verify the design of the theoretical model. It was found that most of the items loaded highly on one common factor which accounted for 32 percent of the variation. This result implied that the instrument tested only one major theme, that is,

TABLE 3. Skewed Response Items

Item	Skewness
42 Computers slow down and complicate simple business operations.	-1.253
27 I feel useless when I sit before a computer.	-1.158
64 I try not to use computers because they break down so often.	-1.151
28 The prompt feedback from computers is somewhat exciting.	1.142
50 A computer is a tool, similar to a hammer or a calculator.	1.118
47 Children should be introduced to computers.	1.115
51 Our country would be better off if there were no computers.	-1.101
71 I hesitate to use a computer for fear of damaging the computer in some way.	-1.087
39 I frequently notice my hand shakes when I attempt to work on a computer.	-1.084
49 A person today cannot escape the influence of computers.	1.030
19 When I hear the word "computer", I have a feeling of dislike.	-1.028
58 Learning about computers is a waste of time.	-1.023

computer anxiety. Six items which had loadings below 0.30 were identified (see Table 5). Items 40, 28, and 59, with extremely low factor loadings on the one common factor probably did not measure the same concept as the other items in the instrument.

TABLE 4. Highly Correlated Items

Item	6	13	16	19	23	27	73
2				0.69			
3	-0.65						
12		0.67	0.67		0.71	0.73	
13					0.68		0.67
15				0.66			
33						0.68	
35							0.68

Item 2. I get a sinking feeling when I think that, no matter what, I have to learn/use computers.
3. Computers are fascinating and fun.
6. I prefer to stay away from computers.
12. Computers make me feel helpless.
13. I feel a sense of insecurity when attempting to use a computer.
15. Computers make me feel so stupid.
16. Computers do not scare me at all.
19. When I hear the word "computer", I have a feeling of dislike.
23. Computers make me feel uneasy and confused.
27. I feel useless when I sit before a computer.
33. I notice I become short of breath when I am asked to do something on computers.
35. Computers make me feel as though I am lost in a jungle of "commands" and cannot find my way out.
73. I have avoided computers because I have had some failure experiences with computers.

4. Cronbach's coefficient alpha of item internal consistence was calculated for the entire instrument and the four sub-sets. The coefficients were high. Table 6 contains the results.

The value of the coefficient alpha reflects (1) average inter-item correlation and (2) the number of items. The higher the mean of inter-item correlation or the more items, the higher the coefficient alpha tends to be. Table 6 revealed this relationship.

TABLE 5. Low Loading Items

Item	Factor Loading
40 People would respect a person more if s/he was really handy in using computers.	0.01
28 The prompt feedback from computers is somewhat exciting.	0.03
59 A person who has not been exposed to computers will be at a disadvantage with those who have.	0.04
49 A person today cannot escape the influence or computers.	0.12
57 Computers are too complicated for the average person to use.	0.17
52 In today's world, everyone should know how to use computers in some way.	0.25

TABLE 6. Reliability of Instrument

Test		Inter-item correlation mean	Coefficient alpha
Item 1-23	Anxiety (general)	0.42	0.94
Item 24-39	Anxiety (experienced)	0.34	0.90
Item 40-59	Attitude	0.22	0.83
Item 60-75	Reason	0.31	0.87
Item 1-75	Computer Anxiety	0.28	0.95

Few items were identified with item-total correlations below 0.30 (see Table 7). For these items, their discriminative ability tended to be low.

5. Seventy-two out of 118 (61%) participants indicated that the size of the font used in the instrument was not too small to read. Another 12 persons (10%) did not respond. The remaining 32 (29%) suggested using a larger size font to improve ease in reading the instrument.

Conclusions

Although evidences showed that a few items tended to be non-discriminating, redundant, or content-inconsistent, they were still included in the field test version of the instrument. This decision was made because a fairly homogenous group was used in this analysis and also the sample size was relatively limited. However, the results did direct the researcher to re-evaluate those "troublesome" items and valuable feedback which was obtained from the participants.

The following conclusions were also drawn from this clinical study:

1. Items and directions of the instrument were clearly stated and easy to understand.
2. On the average, the instrument was completed within 20 minutes (10 to 20) by a college student.
3. The best way of data collection was distributing and collecting the response sheets during the same class period.

TABLE 7. Low Discrimination Items

Item	Item-Total Correlation
28 The prompt feedback from computers is somewhat exciting.	-0.140
59 A person who has not been exposed to computers will be at a disadvantage with those who have.	-0.017
40 People would respect a person more if s/he were really handy in using computers.	0.025
49 A person today cannot escape the influence of computers.	0.145
4 I view computers as handy tools in my life.	0.181
57 Computers are too complicated for the average person to use.	0.200
45 Even if a person does not know any computer language, s/he can still use computers.	0.238
9 I am (will be) proud of knowing how to use computers.	0.242
65 I do not play with computers because they are too expensive to buy.	0.263
62 I have avoided computers because they are unfamiliar to me.	0.266
44 Computers are valuable educational tools.	0.270
41 Computer technology is creating a lot more unhappiness among people than the help it provides.	0.275
67 I have avoided using computers because the radiation may hurt me.	0.283
5 I probably feel more frustrated in attempting to use a computer than other people do.	0.284
43 Our country relies too much on computers.	0.290

4. Although most of the participants were able to complete the instrument within 20 minutes, they still felt that too many items were included.

Based on the results of the pilot study, minor modifications were made in creating the field test instrument:

1. The format for the items was altered to apply a separate computer answer sheet which would simplify the data input procedure and increase the accuracy and efficiency of data manipulation.
2. Three items were re-written, two related to parents' occupations (item 17 and 21), and one related to sex-equality in computer usage (item 7). Three items, 84, 89, and 96, were reworded. Item 84 originally contained a double negative statement.

The revised instrument is included in Appendix H.

Field Test

Two major issues are considered in this section: (1) the evaluation of the computer anxiety instrument, and (2) the interpretation of the nature of computer anxiety.

Fourteen hundred and fifty-four instruments were distributed to four high schools, three community colleges, and five universities (see Appendix I). There were 999 returns (69%). Among the 999 returns, 24 were received after the deadline and not included in the analysis. Table 8 reflects the characteristics of the returned response participants.

Instrument evaluation

A principal factor analysis which used the squared multiple correlations (SMC) as the prior communality estmiate was completed to verify the underlining structure of the instrument. Six factors were extracted with eigenvalues greater than 1.0. A total of 88.2 percent variation was accounted for by these six factors.

Factors were then rotated by an orthogonal transformation (varimax rotation) for better interpretation. Table 9 illustrates the varimax rotated factor loadings of items into six orthogonal factors.

There were 19 items which loaded on factor#1, 16 on factor#2, 14 on factor#3, 10 on factor#4, 11 for factor#5, and only five on factor#6. Eight items loaded greater than 0.40 on two factors, while 10 out of 75 loaded less than 0.40 on any factor.

Table 10 to Table 15 detail the complete factor-structure of the computer anxiety instrument. The interpretation of rotated factors is described as follows:

TABLE 8. The Characteristics of Field-Test Samples

Characteristics	N	Percentage
Sex		
Male	499	51.4
Female	463	47.1
Unknown	9	0.9
	-------	--------
	971	100.0
Age		
11 - 18	249	25.7
19 - 22	355	36.6
23 - 30	199	20.5
31 - 35	68	7.0
36 - 40	36	3.7
41 - 50	12	1.2
51 - 60	4	0.4
Unknown	48	4.9
	-------	--------
	971	100.0
Educational Status		
High School	233	24.0
2-Year Community College	85	8.8
4-Year University	388	40.0
Graduate School	256	26.4
Unknown	9	0.9
	-------	--------
	971	100.0
Major		
Communication	113	11.6
Educational Related	124	12.8
Literature/Arts	133	13.7
Business	159	16.4
Computer Related	64	6.6
Medicine Related	42	4.3
Natural Science	109	11.2
Engineering	56	5.8
Agriculture	32	3.3
Social/Behavioral Science	42	4.3
Unknown/Others	97	10.0
	------	--------
	971	100.0

TABLE 8 (continued)

Characteristics	N	Percentage
Computer Course Taken (Semester Credits)		
Not Taking	596	61.4
1 - 3	150	15.5
4 - 6	99	10.2
7 - 9	42	4.3
10 - 15	40	4.1
16 - 20	13	1.3
21 - 25	12	1.2
26 - 30	7	0.8
31 - 35	5	0.5
36 - 40	2	0.2
Over 40	5	0.5
	971	100.0
Computer Experience		
No experience	99	10.2
Using computer output	335	34.5
Playing computer games	522	53.8
Running packages	469	48.3
Developing program	267	27.5
Knowing more than one language	386	39.8
Earning money from computer related work	163	16.8
Ownership of a Personal Computer		
Yes	212	21.8
No	747	77.0
Unknown	12	1.2
	971	100.0

Factor#1

Factor#1, containing 19 items was bipolar, with four positive items and 15 negative items. The items included were affective items which encompassed two kinds of personal reactions: (1) subjective emotional

TABLE 9. Varimax Rotated Factor Loadings for Six Factors

Factor Description	Item Number	F1	F2	F3	F4	F5	F6
Emotional	31	0.64					
feedback of	44	0.62					
personal inter-	37	0.61					
actions with	38	0.61					
a computer	48	0.59					
	27	0.56					
	40	0.55					
	28	0.54					
	30	0.54					
	35	0.52					
	43	0.52					
	39	0.50					
	52	0.48					
	36	0.47	0.40				
	60	0.46					
	33	0.45			0.44		
	29	0.44	0.40				
	46	0.37					
	49	0.35					
Computer's	72		0.64				
beneficial	78		0.61				
impacts toward	73		0.59				
an individual	69		0.58				
and society	84		0.57				
	81		0.57				
	77		0.56				
	42	0.49	0.50				
	47		0.48				
	34		0.47				
	74		0.43				
	83		0.40				
	75		0.39				
	65		0.35				
	53		0.35				
	70		0.27				

TABLE 9 (continued)

Factor Description	Item Number	F1	F2	F3	F4	F5	F6
Difficulty	96			0.64			
in computer	92			0.63			
implementations	99			0.63			
	94			0.56			
	98			0.52			
	91			0.52			
	86			0.51			
	100			0.50			
	93			0.49			
	87			0.48			
	85			0.47			
	97			0.43	0.42		
	89			0.40			
	82			0.34			
Confidence and	59				0.56		
enjoyment with	45				0.54		
computers	55				0.48		
	63				0.47		
	57				0.43		
	62				0.42		
	54				0.42		
	41	0.41			0.41		
	50				0.40		
	26				0.35		
Computer's	68					0.58	
negative	71					0.52	
impacts toward	66					0.49	
an individual	88					0.48	
and society	76		0.41			0.46	
	80					0.45	
	79		0.42			0.43	
	67					0.42	
	95					0.42	
	90					0.34	
	32					0.27	

TABLE 9 (continued)

Factor Description	Item Number	F1	F2	F3	F4	F5	F6
Physiological	51						0.59
reactions of	58						0.56
personal inter-	64						0.55
actions with	56						0.54
a computer	61						0.51

reactions--dislike, insecurity, apprehensive, fascination, fun, enjoyable, and (2) reactions to the superiority of computers--including such reactions as helpless, stupid, useless, confused, lost, impatient, frustrated, or avoiding, and staying away. In summary, factor#1 revealed the emotional feedback of personal interactions with a computer.

Factor#2

Sixteen items were grouped under factor#2 which demonstrated an openness and optimism about the beneficial impacts of computers for individuals, educational systems, and society. Two major issues were apparent: (1) the belief in the computer's benefits to human beings, and (2) the confidence in computers to improve life situations. The belief or confidence resulted in the desire to learn to use computers. Items such as "computers are beneficial aids to a modern society", "computers are beneficial educational tools", "a person who has been exposed to computers will have an advantage over those who have not", and "everyone should give computers a try" were included.

TABLE 10. Factor#1: Emotional Feedback of Personal Interactions with a Computer

Item	Loading
31. I prefer to stay away from computers.	0.64
44. When I hear the word "computer", I have a feeling of dislike.	0.62
37. Computers make me feel helpless.	0.61
38. I feel a sense of insecurity when attempting to use a computer.	0.61
48. Computers make me feel uneasy and confused.	0.59
27. I get a sinking feeling when I think that, no matter what, I have to learn/use computers.	0.56
40. Computers make me feel so stupid.	0.55
28. Computers are fascinating and fun.	0.54
30. I probably feel more frustrated in attempting to use a computer than other people do.	0.54
35. I am not the type of person who does well with computers.	0.52
43. I (will) avoid certain classes/jobs because of the use of computers.	0.52
39. I feel apprehensive about using a computer.	0.50
52. I feel useless when I sit before a computer.	0.48
36. I (would) enjoy having a home computer.	0.47
60. Computers make me feel as though I am lost in a jungle of "commands" and cannot find my way out.	0.46
33. I feel confident about my ability to deal with computers.	0.45
29. I view computers as handy tools in my life.	0.44
46. Computers make me feel impatient.	0.37
49. I find it difficult to keep my mind on my work while operating a computer.	0.35

Factor#3

There were fourteen items loaded on factor#3. These items described the potential obstacles of the propagation of computers. Worry about physiological injury, such as "straining the eyes" and "injury from the radiation"; misconceptions of computers because of unfamiliarity, such

TABLE 11. Factor#2: Computer's Beneficial Impacts toward an Individual and Society

Item	Loading
72. Children should be introduced to computers.	0.64
78. Computers are beneficial aids to a modern socirty.	0.61
73. Everyone should be willing to give computers a try.	0.59
69. Computers are valuable educational tools.	0.58
84. A person who has been exposed to computers will have an advantage over those who have not.	0.57
81. School-wide emphasis on experimenting with computers should be encouraged.	0.57
77. In today's world, everyone should know how to use computers in some way.	0.56
42. If given an opportunity, I would like to use and learn about computers.	0.50
47. I am looking forward to the time when computers are in all homes.	0.48
34. I am (will be) proud of knowing how to use computers.	0.47
74. A person today cannot escape the influence of computers.	0.43
83. Learning about computers is a waste of time.	0.40
75. A computer is a tool, similar to a hammer or a calculator.	0.39
65. People would respect a person more if s/he was really handy in using computers.	0.35
53. The prompt feedback from computers is somewhat exciting.	0.35
70. Even if a person does not know any computer language, s/he can still use computers.	0.27

as "too complicated to use", "hurting computers in some way", "computers break down easily"; and direct or indirect failure experiences, such as "lack of typing skills", "lack of mathematics techniques", "failure with computers" were included. Factor#3 might be summarized as difficulty in computer implementations.

TABLE 12. Factor#3: Difficulty in Computer Implementations

Item	Loading
96. I hesitate to use a computer for fear of hurting the computer in some way.	0.64
92. I have avoided using computers because the radiation may hurt me.	0.63
99. I hesitate to use a computer for fear of straining my eyes.	0.63
94. I feel nervous with computers because I have to use a computer in a public place.	0.56
98. I have avoided computers because I have had some failure experiences with computers.	0.52
91. I have difficulty using a computer because computers are too complicated.	0.52
86. I do not like to use computers because of the typing skill required.	0.51
100. I do not like to use computers because of the mathematics it requires.	0.50
93. I do not like computers because they may take over my job someday.	0.49
87. I have avoided computers because they are unfamiliar to me.	0.48
85. I hesitate to use a computer for fear of making mistakes that I cannot correct.	0.47
97. I do not like to use computers because I have to spend a lot of time to get familiar with computer commands and system operations first.	0.43
89. I hesitate to use computers because they break down so easily.	0.40
82. Computers are too complicated for the average person to use.	0.34

Factor#4

Factor#4 consisted of 10 items dealing with the confidence, enjoyment and preference in working with computers. A positive attitude or feeling was mainly observed which probably was due to the attraction to computers, or an individual's self-confidence in dealing with computers. For example, "I enjoy the challenge of figuring out how a computer

TABLE 13. Factor#4: Confidence and Enjoyment with Computers

Item	Loading
59. I enjoy the challenge of figuring out how a computer program works.	0.56
45. If available, I would choose computer related work over other possibilities as my future job.	0.54
55. Once I start to work with a computer, I find it hard to stop.	0.48
63. I feel calm and collected even when the computer give me a lot of error messages.	0.47
57. When I get into a computer problem that I cannot figure out immediately, I stick with it until I have the solution.	0.43
62. I enjoy showing someone else how to use a computer.	0.42
54. I perform normally while using a computer just like I usually do with other tools.	0.42
41. Computers do not scare me at all.	0.41
50. I (would) feel calm and collected while someone observed me working with a computer.	0.40
26. I usually have been at ease during occasions when computers were involved.	o.35

program works", "once I start to work with a computer, I find it hard to stop", and "if available, I would choose computer related work over other possibilities as my future job".

Factor#5

Factor#5 expressed the mistrust of computers to improve human living conditions. The belief that the computer has a negative impact on school and society; and the machine's de-humanizing influence were major issues. "Computers isolate people", "prevent normal social

TABLE 14. Factor#5: Computer's Negative Impacts toward an Individual and Society

Item	Loading
68. Our country relies too much on computers.	0.58
71. Computers isolate people by preventing normal social interactions.	0.52
66. Computer technology is creating a lot more unhapienss among people than the help it provides.	0.49
88. I do not like the idea of computers replacing human skills.	0.48
76. Our country would be better off if there were no computers.	0.46
80. I worry about the negative consequences of putting computers in schools.	0.45
79. Computers have no place in the classroom.	0.43
67. Computers slow down and complicate simple business operations.	0.42
95. I do not like to use computers because they are impersonal.	0.42
90. I do not play with computers because they are too expensive to buy.	0.34
32. I would rather take a paper-pencil test than answer questions through a computer.	0.27

interactions", "replace human skills", "create more unhappiness than they help"; and "society relies too much on computers", "no computer, we would be better off" were the major components of factor#5.

Factor#6

Five items were grouped into factor#6 which illustrated the physiological reactions toward a computer, such as heart pounding, shortness of breath, hands shaking, and sweating.

TABLE 15. Factor#6: Physiological Reactions of Personal Interactions with a Computer

Item	Loading
51. I notice my heart pounding when I am asked to finish some jobs on computers.	0.59
58. I notice I become short of breath when I am asked to do something on computers.	0.56
64. I frequently notice my hand shakes when I attempt to work on a computer.	0.55
56. I sweat very easily when manipulating a computer.	0.54
61. Sometimes my mind goes blank, and I am unable to think clearly when working with computers.	0.51

The interpretation of the six extracted factors is summarized as follow:

Factor#1: Emotional feedback of personal interactions with a computer;

Factor#2: Computer's beneficial impacts toward an individual and society;

Factor#3: Difficulty in computer implementations;

Factor#4: Confidence and enjoyment with computers;

Factor#5: Computer's negative impacts toward an individual and society;

Factor#6: Physiological reactions of personal interactions with a computer.

By comparing the above six identified factors with the theoretically selected domains--cognitive, affective, behavioral, physiological reactions; and the classified headings--feelings and reactions toward computers, attitude toward computers, and reasons for not using or learning computers, the extracted factors seemed to be the combinations of two prior settings, and probably described more concretely the nature of computer anxiety. But these factors are not unique, there are many other possible factors which could also explain the characteristics of the computer anxiety. The identified factors were adopted as six composite dimensions of the instrument for the following analysis.

From the results of factor analysis, a shortened instrument including 57 items was determined by excluding 10 low factor loading (<0.40) items and eight ambiguous items which were highly loaded on two factors. The purpose of constructing a shortened instrument was to offer a more practical version which would take less time to complete for future use. Appendix L contains the shortened instrument.

Reliability analysis

Reliability indices were calculated for both the original instrument and the shortened instrument. Table 16 contains the results of the reliability analysis.

The shortened instrument, by discarding the ambiguous and low loading items, tended to have a higher item-internal correlation and a higher reliability. α' indicates the estimation of the reliability if the shortened instrument were expanded into the same length as the long form.

TABLE 16. Reliability Index of Two Instruments

	Long Form				Short Form		
	N	r		N	r		
Factor#1	19	0.44	0.94	14	0.49	0.93	0.95
Factor#2	16	0.29	0.86	11	0.34	0.85	0.89
Factor#3	14	0.38	0.90	12	0.40	0.89	0.90
Factor#4	10	0.32	0.83	8	0.33	0.80	0.83
Factor#5	11	0.32	0.83	7	0.34	0.75	0.85
Factor#6	5	0.44	0.79	5	0.44	0.79	0.79
Total	75	0.26	0.96	57	0.27	0.95	0.97

N: Total number of items
r: Inter-item correlation mean
: Coefficient alpha
: Estimated coefficient alpha

The correlations of the two instruments are also displayed in Table 17. The two instruments were highly correlated. It was suggested that a shortened form would be sufficient to substitute for the original long form.

Variables contributing to computer anxiety

Twenty-two hypothetical factors were considered as sources contributing to computer anxiety. Included are three discrete variables: age, general trait anxiety (TTRAIT), and the number of credits of computer related course (TCOURSE); and 19 continuous variables: school, major, educational status (EDL), gender (SEX),

TABLE 17. *Correlations of the Long Form and Short Form Instruments*

Correlated Pairs	Correlations
LFF1 vs SFF1	0.980
LFF2 vs SFF2	0.976
LFF3 vs SFF3	0.980
LFF4 vs SFF4	0.954
LFF5 vs SFF5	0.931
LFF6 vs SFF6	0.975
LTOL vs STOL	0.995

LFF: Long Form Factor LTOL: Long Form Total
SFF: Short Form Factor STOL: Short Form Total

ownership of personal computer(PC), favorable feeling toward mathematics (LMATH), ability in mathematics (MATHA), belief of sex-equality in learning to use a computer (MF1) and access toward computers (MF2), father's/mother's occupation (FOC/MOC), father's/mother's educational level (FED/MED), father's/mother's attitude toward an individual's learning or using computers (FAT1/MAT1), father's/mother's attitude toward computers (FAT2/MAT2), school's environment for learning computers (SCHL), and previous computer experiences (TEXPR).

Collinearity The collinearity of initiated predictive variables was examined by a correlation matrix. The pairs which contained a correlation coefficient greater than 0.40 are listed as follows:

Correlated Pairs			Correlations
FAT1	vs	FAT2	0.69
MAT1	vs	MAT2	0.65
AGE	vs	EDL	0.63
LMATH	vs	MATHA	0.58
FED	vs	MED	0.49
FAT1	vs	MAT1	0.49
FAT2	vs	MAT2	0.41

EDL, MATHA, FAT1, FAT2, MAT2, and FED were identified with ratively high correlation sand were excluded from the analysis in order to avoid unstable estimation and high standard errors.

Analysis of variance An analysis of variance (ANOVA), using the general linear model approach (GLM), was performed to examine if significant computer anxiety differences existed among the subgroups of gender (SEX), use or non-use of computers (USE), high school students versus non-high school students (HIGH) and the combined groups of these three factors (SEX*USE, SEX*HIGH, USE*HIGH). This preliminary step was conducted to determine if separate regression analyses within the subgroups combinations were needed to identify the significant variables of computer anxiety in each factor.

Significant differences were found in factor#1 of USE groups; in factor#3 of USE*HIGH groups; in factor#4 of SEX and SEX*HIGH groups (see Table 18). The results suggested that separated regression analyses were necessary for subgroups of factor#1, factor#3, and factor#4. For factor#2, factor#5, and factor#6 an overall regression analysis would be sufficient.

TABLE 18. Results of Analysis of Variance for Three Factors--SEX, USE, and HIGH

Source	SS	F	df	P	Mean		N
Factor#1							
USE	7.48	4.44	1, 839	0.0255*	U	0.00	690
					N-U	0.50	157
Factor#3							
USE*HIGH	3.86	4.79	1, 839	0.0290*	U/H	0.21	152
					U/N-H	-0.06	538
					N-U/H	-0.13	6
					N-U/N-H	0.31	151
Factor#4							
GENDER	14.42	10.26	1, 839	0.0001***	M	-0.10	
					F	0.14	411
GENDER*HIGH	3.59	5.11	1, 839	0.0240*	M/H	-0.34	85
					F/H	0.16	72
					M/N-H	-0.04	350
					F/N-H	0.14	339

U : USE　　H: High school　　M: Male
N-U: Non-USE　　N-H: Non-High school　　F: Female

* :Significant at 0.05 level.
***:Significant at 0.001 level.

By examining the means of subgroups from ANOVA analysis, the following results were found:

1. Factor#1, non-computer-users (NON-USE) had a higher anxiety than computer-users (USE).

2. Factor#3, non-high school/computer users (NON-HIGH/USE) tended to have a lower anxiety than high school/computer users (HIGH/USE); but non-high school/non-computer users (NON-HIGH/NON-USE) tended to have a higher anxiety than high school/non-users (HIGH/NON-USE). Figure 3 illustrates the relationships of these four groups.
3. Factor#4, females had higher anxiety than males. Female/non-high school (FEMALE/NON-HIGH) had a lower anxiety than female/high school (FEMALE/HIGH); but male/non-high school (MALE/NON-HIGH) had a higher anxiety than male/high school (MALE/HIGH) groups. Figure 4 illustrates the relationships of these four groups.

Regression Analysis Factor scores, which have a mean of zero and variance equal to the squared multiple correlation of the factor with other variables, were obtained from multiple regression equations by the least square estimation. Estimated fator scores were used as the indicators of computer anxiety. Sixteen predictive variables--AGE, TTRAIT, TCOURSE, SCHOOL, MAJOR, SEX, PC, MATH, MF1, MF2, FOC, MOC, PARED, PARAT, SCHL, TEXPR were included in the regression model to determine their major contribution to the variance of computer anxiety. Due to the unequal sample size existing among subgroups of included predictive variables a general linear model approach (GLM in SAS) was used to reduce the error of the analysis. Results identified the variables which related significantly to the anxiety factor scores.

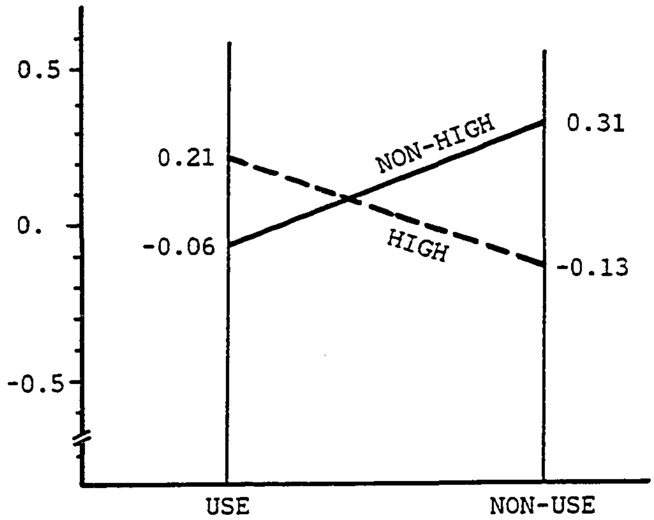

FIGURE 3. Relationships of USE*HIGH Groups on Factor#3

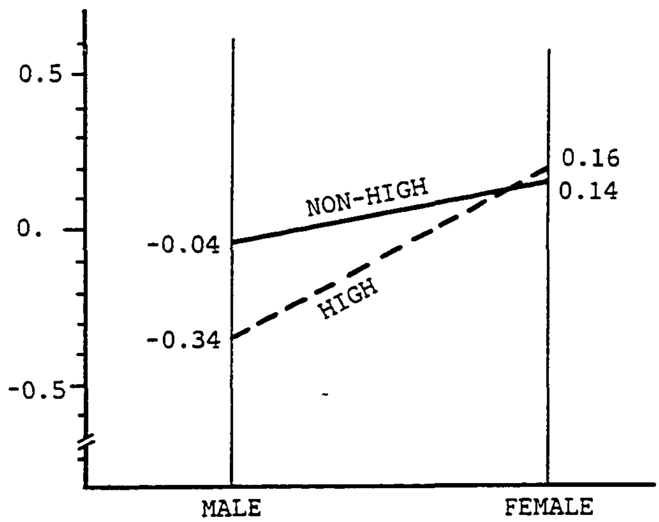

FIGURE 4. Relationships of SEX*HIGH Groups on Factor#4

Scheffé's S procedure was then used to calculate the post-hoc comparisons of those significant variables among their subcategories. Table 19 through Table 24 display the major results of each factor.

Results

Factor#1: Emotional feedback of personal interactions with a computer (see Table 19).

It was found from preliminary ANOVA that differences existed between computer users versus non-users.

*Common significant variables in computer users and non-users:

TTRAIT (the lower the trait anxiety, the lower the factor#1 score)

*Significant variables of computer non-users (NON-USE):

TTRAIT

*Significant variables of computer users (USE):

TTRAIT

TCOURSE (the more computer related courses taken, the lower the factor#1 score)

MATH (difference existed between like and dislike groups)

MF2 (no significant difference existed between subgroups)

PARAT (difference existed between strongly encouraged and neutral groups)

SCHL (differences existed between strongly encouraged and encouraged groups; and strongly encouraged and no influence groups)

TABLE 19. Significant Predictors of Factor#1--Emotional Feedback of Personal Interactions with a Computer

Source	SS	F	df	P	Mean	N
Non-Users						
TTRAIT	6.64	8.01	1, 85	0.0058**		
Users						
TTRAIT	10.37	14.35	1, 571	0.0002***		
TCOURSE	3.46	4.79	1, 571	0.0290*		
MATH	15.09	5.22	4, 571	0.0004***	E: 0.63	30
					D: 0.40	64
					C: 0.11	176
					B:-0.13	263
					A:-0.26	101
MF2	7.09	2.46	2, 571	0.0447*	B: 0.04	426
					A:-0.03	120
					C:-0.13	82
PARAT	8.47	3.91	3, 571	0.0089*	C: 0.16	208
					D: 0.02	6
					B: 0.01	260
					A:-0.21	160
SCHL	6.90	2.39	4, 571	0.0499	E: 0.75	3
					C: 0.16	139
					B: 0.05	316
					D:-0.00	16
					A:-0.23	160

Mean Categories:

MATH	A: Like very much	B: Like	C: So-so
	D: Dislike	E: Definitely dislike	
MF2	A: Agree	B: Disagree	C: Uncertain
PARAT,	A: Strongly encourages	B: Encourages	C: Neutral
SCHL	D: Discourages	E: Strongly discourages	

* :Significant at 0.05 level.
** :Significant at 0.01 level.
***:Significant at 0.001 level.

*Characteristics of higher factor#1 score of computer users:

1. get anxious easily;
2. take few computer related courses;
3. dislike math;
4. agree that females were encouraged to seek computer related jobs;
5. stay in a school which discouraged the learning or use of computers; or
6. their parent objected to the learning or use of computers.

Factor#2: Computers beneficial impacts toward an individual and society (see Table 20)

*Significant variables:

AGE (the younger a person, the higher their factor#2 score)

TTRAIT (the higher the trait anxiety, the lower the factor#2 score)

TCOURSE (the more computer related courses taken, the lower the the factor#2 score)

SCHOOL (no significant difference was found between schools)

MF1 (differences existed between agree and uncertain groups)

PARAT (differences existed between strongly encouraged with encouraged and uncertain groups)

SCHL (differences existed between strongly encouraged with encouraged and no influence groups)

*Characteristics of higher factor#2 score participants:

1. young;

TABLE 20. Significant Predictors of Factor#2--Computer's Beneficial Impacts toward an Individual and Society

Source	SS	F	df	P	Mean	N
AGE	9.24	12.66	1, 711	0.0004***		
TTRAIT	4.71	6.46	1, 711	0.0113*		
TCOURSE	3.60	4.93	1, 711	0.0267*		
SCHOOL	13.85	1.90	10, 711	0.0425*	C: 0.47	21
					I: 0.28	15
					A: 0.12	206
					D: 0.07	18
					M: 0.04	115
					E: 0.01	33
					H: 0.01	24
					F:-0.02	88
					L:-0.11	45
					J:-0.16	190
					B:-0.16	21
MF1	7.77	5.32	2, 711	0.0051**	C: 0.61	33
					B: 0.38	25
					A:-0.04	718
PARAT	30.13	10.32	4, 711	0.0001***	C: 0.23	270
					B: 0.06	307
					D:-0.06	6
					E:-0.35	1
					A:-0.41	192
SCHL	6.44	2.20	4, 711	0.0669	C: 0.16	197
					B: 0.04	383
					D:-0.03	16
					E:-0.10	4
					A:-0.25	176

Mean Categories:

MF1	A: Agree	B: Disagree	C: Uncertain
MF2	A: Agree	B: Disagree	C: Uncertain
PARAT,	A: Strongly encourages	B: Encourages	C: Neutral
SCHL	D: Discourages	E: Strongly discourages	
SCHOOL	D,E,F,H: High schools		
	C,I,L: Community colleges		
	A,B,J,K,M: Colleges/Universities		

* :Significant at 0.05 level.
** :Significant at 0.01 level.
***:Significant at 0.001 level.

2. do not get anxious easily;
3. take few computer related courses;
4. community college students;
5. uncertain that male and female are equally capable in computer learning;
6. their parent maintained a neutral attitude toward computers; or
7. not being influenced by school board's attitude toward computers.

Factor#3: Difficulty in computer implementations (see Table 21).

Results showed from the ANOVA analysis that differences existed among HIGH and USE combined groups. Four combinations of high school students or non-high school students, computer users or non-computer users were discussed.

*Common significant variables of HIGH*USE groups:

None

*Significant variables of NON-HIGH/NON-USE group:

TTRAIT (the lower the trait anxiety, the lower the factor#3 score)

*Significant variables of HIGH/NON-USE group:

Insufficient sample size for analysis

*Significant variables of HIGH/USE group:

TCOURSE (the more computer related courses taken, the lower the factor#3 score)

TABLE 21. Significant Predictors of Factor#3--Difficulty in Computer Implementations

Source	SS	F	df	P	Mean	N
NON-HIGH/NON-USE						
TTRAIT	3.07	4.72	1, 80	0.0328*		
HIGH/USE						
TCOURSE	3.23	4.63	1, 85	0.0342*		
NON-HIGH/USE						
TCOURSE	7.24	10.93	1, 435	0.0010**		
SCHL	8.92	3.37	4, 435	0.0099**	E: 0.35	3
					B: 0.02	240
					C:-0.16	110
					A:-0.20	132
					D:-0.26	10
HIGH/NON-USE						
Too few samples in the group to be analyzed						

Mean Categories:
SCHL A: Strongly encourages B: Encourages C: Neutral
D: Discourages E: Strongly discourages

* :Significant at 0.05 level.
** :Significant at 0.01 level.

*Significant variables of NON-HIGH/USE group:

TCOURSE (the more computer related courses taken, the lower the factor#3 score)

SCHL (no significant difference existed between subgroups; schools which strongly discouraged the learning or use of computers resulted also in a higher factor#3 score)

TABLE 22. Significant Predictors of Factor#4--Confidence and Enjoyment with Computers

Source	SS	F	df	P	Mean	N
MALE						
TTRAIT	2.98	4.60	1, 337	0.0326*		
MAJOR	11.56	1.78	10, 337	0.0629	J: 0.25	12
					B: 0.23	44
					G: 0.09	42
					A: 0.02	51
					I: -0.03	76
					E: -0.03	45
					H: -0.09	15
					C: -0.11	23
					F: -0.16	37
					K: -0.22	22
					D: -0.84	32
MATH	9.49	3.66	4, 337	0.0062**	D: 0.32	34
					E: 0.32	16
					C: 0.11	110
					B: -0.16	170
					A: -0.39	69
MF1	3.61	2.79	2, 334	0.0631	C: -0.01	23
					A: -0.06	360
					B: -0.39	16

* :Significant at 0.05 level.
** :Significant at 0.01 level.
***:Significant at 0.001 level.

TABLE 22 (continued)

Source	SS	F	df	P	Mean	N
FEMALE						
SCHOOL	10.19	2.01	10, 317	0.0332*	F: 0.42	50
					A: 0.26	102
					M: 0.24	49
					J: 0.10	100
					I: -0.01	15
					C: -0.16	11
					D: -0.22	3
					E: -0.22	17
					L: -0.24	26
					H: -0.40	2
					B: -1.32	1
PC	4.09	4.01	1, 317	0.0191*	B: 0.18	307
					A: -0.05	67
MATH	13.83	6.78	4, 317	0.0001***	E: 0.79	29
					D: 0.30	51
					C: 0.23	106
					B: 0.08	141
					A: -0.38	49
PARAT	3.78	2.47	3, 317	0.0608	C: 0.32	109
					B: 0.17	165
					A: -0.07	99
					D: -0.45	3

TABLE 22 (continued)

Source	SS	F	df	P	Mean	N
FEMALE/HIGH						
no significant finding						
FEMALE/NON-HIGH						
TCOURSE	2.04	3.80	1, 254	0.0522	B: 0.18	253
PC	4.51	4.21	1, 254	0.0160*	A: -0.03	55
MATH	12.66	5.90	4, 254	0.001***	E: 0.79	26
					D: 0.29	48
					C: 0.22	88
					B: 0.07	112
					A: -0.41	36
MALE/HIGH						
no significant finding						
MALE/NON-HIGH						
TTRAIT	3.76	5.28	1, 261	0.0166*		
MATH	10.31	3.99	4, 261	0.0037**	D: 0.52	25
					E: 0.36	15
					C: 0.21	84
					B: -0.17	144
					A: -0.31	54
MF1	4.69	3.63	2, 251	0.0279*	A: 0.01	292
					C: 0.09	18
					B: -0.41	12

Mean Categories:

MAJOR	A: Communication	B: Natural Science	C: Agriculture
	D: Computer related	E: Education related	F: Engineering
	G: Literature & Arts	H: Medical related	I: Business
	J: Social/Behavior Science		K: Others
MATH	A: Like very much	B: Like	C: So-so
	D: Dislike	E: Definitely dislike	
MF1	A: Agree	B: Disagree	C: Uncertain
PC	A:Yes	B: No	
PARAT	A: Strongly encourages	B: Encourages	C: Neutral
	D: Discourages	E: Strongly discourages	
SCHOOL	D,E,F,H: High schools		
	C,I,L: Community colleges		
	A,B,J,K,M: Colleges/Universities		

<u>Factor#4</u>: Confidence and enjoyment with computers (see Table 22)

The preliminary ANOVA analysis showed that factor#4 score differed between SEX and SEX*HIGH combined groups.

*Common significant variables for MALE and FEMALE groups:

MATH (Those who liked math tended to have lower factor#4 score)

*Significant variables for MALE group:

TTRAIT (the lower the trait anxiety, the lower the factor#4 score)

MATH (differences existed between like and dislike groups)

*Significant variables for FEMALE group:

SCHOOL (no significant difference was found between schools)

PC (females who owned personal computers tended to have lower factor#4 scores)

MATH (differences existed between like and dislike groups)

PARAT (differences existed between strongly encouraged and neutral groups, parent's encouragement tended to decrease the factor#4 score)

*Common significant variables for SEX*HIGH combined groups:

None

*Significant variables for FEMALE/NON-HIGH group:

TCOURSE (The more computer related courses taken, the lower the factor#4 score)

PC (female and non-high school students who owned personal computers tended to have lower factor#4 scores)

MATH (differences existed between like and dislike groups, those who liked math tended to have lower factor#4 scores)

*Significant variables for MALE/NON-HIGH group:

TTRAIT (the lower the trait anxiety, the lower the factor#4 score)

MATH (differences existed between like and dislike groups, those who liked math tended to have lower factor#4 scores)

MF1 (no significant difference existed in subgroups, males who agreed that males and females are equally capable in computer learning tended to have higher factor#4 scores)

There was no significant difference found in FEMALE/HIGH and MALE/HIGH groups.

TABLE 23. Significant Predictors of Factor#5--Computer's Negative Impacts toward an Individual and Society

Source	SS	F	df	P	Mean	N
TTRAIT	4.66	6.63	1, 711	0.0103*		
PC	6.47	2.30	1, 711	0.0574	B: 0.08	602
					A:-0.17	168
MF1	6.66	4.73	2, 711	0.0091**	B: 0.55	25
					C: 0.31	33
					A: 0.00	718

Mean Categories:

PC	A:Yes	B: No	
MF1	A: Agree	B: Disagree	C: Uncertain

* :Significant at 0.05 level.
** :Significant at 0.01 level.

Factor#5: Computer's negative impacts toward an individual and society (see Table 23).

Significant variables:

TTRAIT (the lower the trait anxiety, the lower the factor#5 score)

PC (the personal computer owners tended to have lower factor#5 scores)

MF1 (significant difference was found between agree and disagree groups)

*Characteristics of higher factor#5 score participants:

1. get anxious easily;
2. do not own a personal computer; or
3. disagree that males and females are equally capable in learning computers.

Factor#6: Physiological reactions of personal interactions with a computer (see Table 24).

*Significant variables:

TTRAIT (The lower the trait anxiety, the lower the factor#6 score)

MAJOR (no significant difference existed between different majors)

MF1 (differences existed between neutral with agree and disagree groups)

MF2 (no significant difference was found between subgroups)

*Characteristics of higher factor#6 score participants:

1. get anxious easily;
2. major in computer related areas;

TABLE 24. Significant Predictors of Factor#6--Physiological Reactions of Personal Interactions with a Computer

Source	SS	F	df	P	Mean	N
TTRAIT	15.46	26.72	1, 711	0.0001***		
MAJOR	12.68	2.19	10, 711	0.0167*	D: 0.31	56
					K: 0.23	43
					H: 0.21	25
					F: 0.11	39
					E: 0.04	91
					I: 0.04	145
					B:-0.06	104
					J:-0.08	37
					G:-0.17	110
					C:-0.19	29
					A:-0.24	97
MF1	5.61	4.85	2, 711	0.0081**	C: 0.44	33
					A:-0.03	718
					B:-0.14	25
MF2	7.43	3.21	2, 711	0.0125*	C: 0.03	104
					B: 0.02	518
					A:-0.18	148

Mean Categories:

MF1	A: Agree	B: Disagree	C: Uncertain
MF2	A: Agree	B: Disagree	C: Uncertain
MAJOR	A: Communication	B: Natural Science	C: Agriculture
	D: Computer related	E: Education related	F: Engineering
	G: Literature & Arts	H: Medical related	I: Business
	J: Social/Behavior Science		K: Others

* :Significant at 0.05 level.
** :Significant at 0.01 level.
***:Significant at 0.001 level.

3. uncertain that males and females are equally capable in learning computers; or
4. uncertain that females are encouraged to seek a computer related job.

TABLE 25. Major Contributors of Computer Anxiety Variation

Factor#1	Factor#2	Factor#3	Factor#4
NON-USE	AGE	NON-HIGH/NON-USE	MALE
TTRAIT	TTRAIT	TTRAIT	TTRAIT
USE	TCOURSE	HIGH/USE	MATH
TTRAIT	SCHOOL	TCOURSE	FEMALE
TCOURSE	MF1	NON-HIGH/USE	SCHOOL
MATH	PARAT	TCOURSE	PC
MF2AT	SCHL	SCHL	MATH
PARAT			PARAT
SCHL			FEMALE/NON-HIGH
			TCOURSE
			PC
			MATH
Factor#5	**Factor#6**		
TTRAIT	TTRAIT		MALE/NON-HIGH
PC	MAJOR		TTRAIT
MF1	MF1		MATH
	MF2		MF1

Factor#1: Emotional feedback of personal interactions with a computer
Factor#2: Computer's beneficial impacts toward an individual and society
Factor#3: Difficulty in computer implementations
Factor#4: Confidence and enjoyment with computers
Factor#5: Computer's negative impacts toward an individual and society
Factor#6: Physiological reactions of personal interactions with a computer

Table 25 includes a summary of the major causes listed within the six factors. Trait anxiety was the most common factor which positively correlated with most of the computer anxiety factors. A nervous or anxious person tended to elevate higher computer anxiety. This finding supported the suggestion of Zuckerman (1971) that "...trait anxiety should correlate moderately with the mean of a number of other anxiety."

MATH was one of the other major causes especially related to the confidence or enjoyment of using or learning computers (Factor#4). It seems that a person who performs well in math also tends to feel more confident and enjoys working with computers. It may not be true that success in learning or using computers is based on math ability, but familiarity with math does facilitate the understanding of learning or using computers.

Personal computer owners who become familiar with computers more quickly than non-owners, tend to improve the machine-human relationship easily, which results in more enjoyment or appreciation of computers. This was especially true for females who are usually less exposed to machines. Evidence which appeared in factor#4 and factor#5 supported this point.

The more computer related courses taken will also alleviate some of the difficulties of learning or using computers. The computer courses offer direct opportunities and contacts to realize the nature and characteristics of computers and actually reduce the computer anxiety as well as modify the negative attitude of individuals.

Other than the factors mentioned above, parents' and school's encouragement also help to reduce an individual's computer anxiety.

Reasons for Not Using or Learning Computers

Participants with no hands-on computer experience were selected to determine the major reasons for not using or learning computers. One hundred and seventy-six persons were identified. Among them, 82 were males, 89 were females; 48 were high school students, and 127 were non-high school students. Item#85 through item#100 were considered as possible reasons and rank ordered by the frequency of selections. Table 26 shows the rank order within each interested group. Rank 1 represents the highest frequency selection.

De-humanization, costs, unfamiliarity, and time-consumption for learning (items 88, 90, 87, 97) were the major selections. Only a few participants chose "the instability of computers", "using computer in a public place", "getting hurt by radiation from computers", and "straining the eyes" (items 89, 94, 99, 92) as their reasons. High school students selected more "damaging computers in some way" and fewer chose "the mathematics requirement" than the rest of the groups. This was probably due to their primary understanding about computers.

Other than the possible reasons listed in Table 26, quite a few participants recorded their own reasons on answer sheets. Time conflicts, lack of opportunities or availability, not relating to the study field and no interest, were the major reasons cited. High school students also listed "too complicated" as one of the reasons. There were only 10 out of the 288 respondents who listed "anxiety", "fear of machine", or "scare" as a typical reason. In summary, the essential

TABLE 26. Rank Order of Reasons for Not Using Computers

Item	HIGH	NON-HIGH	M	F	ALL
85. Fear of making mistakes that cannot be corrected	5	9	8	5	6
86. The typing skill required	6	7	5	7	7
87. Computers are unfamiliar to me	2	3	2	3	3
88. Computers replacing human skills	1	1	3	1	1
89. Computers break down so easily	15	12	13	13	13
90. Too expensive to buy	2	1	1	2	2
91. Too complicated	6	6	6	5	5
92. The radiation may hurt	14	16	15	16	16
93. Take over my job someday	8	10	8	9	9
94. Have to use in a public place	10	14	14	13	13
95. Impersonal	11	7	7	10	9
96. Fear of damaging the computer in some way	8	13	12	11	12
97. Spend a lot of time getting started	4	4	4	4	4
98. Failure experiences	11	11	10	12	11
99. Fear of straining the eyes	13	14	15	15	15
100. The math required	15	5	11	7	8

reason for not learning or using a computer could be concluded as "no need". It was also found that only a few of the participants who had no computer experience planned to learn computers in the near future.

CHAPTER V SUMMARY, CONCLUSIONS, DISCUSSIONS, AND RECOMMENDATIONS

Summary

The main purpose of this study was to develop an instrument which could be used to collect data for analysis purposes that would facilitate the understanding of the nature and characteristics of computer anxiety. A theoretical model, which was built based on the current understanding of anxiety and computers, was used to develop a paper-pencil, self-report computer anxiety instrument. Item scale value construction and pilot study procedures were conducted to determine the scoring, validity and reliability of the measurements. A short form instrument which excluded 18 low loading or ambiguous items from the original long form was determined to offer a time-economical instrument for future uses.

Six orthogonal factors were extracted from the factor analysis, which verified the content components of the theoretical model, and suggested a framework of a tentative computer anxiety model. It was concluded from this study that: (1) Emotional feedback of personal interactions with a computer, (2) Computer's beneficial impacts toward an individual and society, (3) Difficulty in computer application, (4) Confidence and enjoyment with computers, (5) Computer's negative impacts toward an individual and society, and (6) Physiological feedback of personal interactions with a computer, were the six measurable variables of a psychological construct--computer anxiety. Measurements based on these six variables are sufficiently inclusive to reveal the intensity of computer anxiety.

Major contributors of the variance of six computer anxiety factors were identified by analysis of variance and multiple regression analysis methods. Results showed that trait anxiety, performance in mathematics, and computer courses taken, were the common factors identified in this study. Ownership of personal computers directly affected the anxiety level of females. For computer users and males above college level, the belief of sex-equality of computers tended to elevate computer anxiety. Parents' attitude and school board's approval also contributed to reduce computer anxiety. Table 27 contains a summary of the results.

TABLE 27. Significant Predictive Variables of Computer Anxiety

Sources	Computer Anxiety Variables
TTRAIT	Factor 1, 2, 3, 4, 5, 6
TCOURSE	Factor 1, 2, 3, 4
MATH	Factor 1, 4
PC	Factor 4, 5
MF1	Factor 2, 4, 5, 6
MF2	Factor 1, 6
PARAT	Factor 1, 2, 4
SCHL	Factor 1, 2, 3
SCHOOL	Factor 4
MAJOR	Factor 6
AGE	Factor 2

De-humanizing effects, costs of computer learning, unfamiliarity with computers, and time-consuming aspects of learning computers were the four major reasons selected consistently by high school students, non-high school students, males, and females. Other than these four reasons, time conflicts, lack of opportunities or availability, not relating to the study field, and no interest were reasons identified by non-computer users for not learning or using computers. Few of the respondents pointed out "anxiety" as a reason. A low desire to learn or use computers was found predominantly among the non-computer users.

Conclusions

Results and findings were concluded to answer the following research questions:

1. Was the theoretical model used in developing the computer anxiety instrument appropriate?

   Four tentative domains--cognitive, affective, physiological, and behavioral were used to initiate a computer anxiety instrument. Research results suggested the use of six dimensions--emotional feedback of personal interactions with a computer, computer's beneficial impacts toward an individual and society, difficulty in computer implementations, confidence and enjoyment with computers, computer's negative impacts toward an individual and society, and physiological feedback of personal interactions with a computer, as the principal components of the computer anxiety model. The new dimensions accounted for 88.2 percent of the variation of the total items and provided a manageable interpretation of the characteristics of computer anxiety.

2. Were the items included in instrument clearly stated and able to discriminate between the potentially low anxious and high anxious persons?

   Responses indicated that items were understandable and easy to read. Inter-item correlation, as well as factor loading, served as the two discriminative indices to evaluate the items. Eighteen items were identified from the field test instrument as low discriminating items. The average inter-item correlations of six computer anxiety variables were 0.49, 0.34, 0.40, 0.33, 0.34, 0.44, after the exclusion of the low discriminate items.

3. Was the instrument developed in this study valid and reliable?

   The appropriateness of items evaluated by the faculty members served as a critical part of the instrument development procedure. The results of factor analysis indicated that 88.2 percent of the variation was accounted for by the six identified factors. Cronback's item internal consistency coefficient alpha was calculated to determine the reliability of instrument. A 0.96 reliability was found in the original instrument (75 items), and a 0.95 reliability was found in the shortened instrument (57 items).

4. What were the major factors which contribute to the variance of anxiety toward computers? Could these factors be improved and

manipulated? Were most of these factors an individual's traits or situational transitory factors in nature?

The significant factos which contributed to the variance of computer anxiety were identified separately within six identified computer anxiety factor scors. Details were presented in Chapter IV. In summary, trait anxiety, computer courses taken, math performance, ownership of personal computer, parents' and school boards' attitude were the factors related significantly to computer anxiety. Among those factors, trait anxiety is a relatively stable personal trait and probably can't be improved greatly. Others were situational transitory factors which may be modified cr possibly reduced.

5. Do the major contributors of computer anxiety differ between males versus females, and high school students versus non-high school students?

Differences were found between male and female groups in only one of the six variables--confidence and enjoyment with computers. Trait anxiety and math performance were two major factors related to the male group. Ownership of a personal computer, math performance, school owned, and parents' attitude were the significant factors related to the female group.

Differences did not exist between high school students and non-high school students, however, differences were found in high school, non-high school, user and non-user combined groups on factor#3--

difficulty in computer implementations; and sex, high school, and non-high school combined groups on factor#4--confidence and enjoyment of computers. Following are the summarized results:

Factor#3

HIGH/USE: Computer courses taken

NON-HIGH/USE: Computer courses taken and attitude of school board

Factor#4

FEMALE/HLGH: Trait anxiety, math performance, and ownership of personal computer

MALE/HIGH: Trait anxiety, math performance, and belief of sex-capability in learning computers

6. Were particular types or groups or individuals prone to have higher computer anxiety? Who were these types or groups of individuals?

Potentially computer anxious groups were found within each of the anxiety variables. Details were provided in Chapter IV. Specifically, persons with high trait anxiety, taking fewer computer courses, not performing well in mathematics, not owning a personal computer, or being discouraged by parents or the school board about the importance of learning or using a computer tended to have a higher computer anxiety.

Discussions

1. Although a tentative computer anxiety model, including six computer anxiety variables, was identified from this study and accounted for up to 88.2 percent of the variation, the model is not unique. Other variables can be identified based on the different theoretical entries which may be assumed to be the measurable or observable indices of computer anxiety.
2. Caution is suggested concerning the results of analysis of variance of computer anxiety. The reader should not be misled by the significant predictive variables found in this study. The findings actually depended (1) the model used in the analysis and (2) the samples selected. From the reported R square value of ANOVA or regression analysis (range from 0.13 to 0.73), other variables, or interactions of variables are needed to add to the analysis in order to find a better-fit model to explain the difference of computer anxiety. Also a quadratic or cubic relationship other than the linear relationship might be considered in the expansion of this model. Samples included in this study were four student groups--high schools, community colleges, colleges/universities, and graduate schools. They are a biased group with a limited range of age, personal background, and social experiences. The generalizations are meaningful only to groups with similar characteristic groups.
3. Unbalanced sample size in subgroups, and collinearity among initiated predictive variables were the two crucial problems encountered in the analysis. Although EDL, MATHA, FED, FATA1, FATA2, MAT1 were excluded

from the model to avoid including the highly correlated variables in the analysis, the exclusion was based on the examination of a correlation matrix. A more precise approach was needed. Unbalanced data were found in all of the subgroups except SEX. This happened because the data were collected based on convenience rather than controlled by the desired characteristics.

4. Two contrary results were found in this study: (1) a negative correlation was found between trait anxiety and factor#2--computer's beneficial impacts toward an individual and society. A repeated study is needed to examine and verify this point. (2) Computer related majors possessed a higher anxiety score on Factor#6--physiological feedback of personal interactions with a computer. The physiological domain was included based on the computer-as-process theory suggesting that the results of anxiety as a sequence of cognitive, affective, behavioral, and physiological events that may be initiated by a stressful external stimulus, or by an internal cue that is perceived or interpreted as dangerous or threatening to an individual. A repeated study concerned with the differences in factor#6 computer anxiety among different major groups is recommended to verify this finding.

5. Interesting results were found on MATH, PC, MF1, and MF2 predictive variables.

   (1) A female personal computer owner tended to have low computer anxiety, but the ownership of personal computer did not make any difference to males.

(2) Males, especially above college level, who agreed that males and females are equally capable in learning about computer, suffer more computer anxiety.

(3) Computer users who disagreed that females are less likely encouraged to seek a job related to computers also suffered more computer anxiety.

(4) MATH especially related to factor#4--confidence and enjoyment with computers. A tendency suggested that the better the math performance, the lower the computer anxiety factor#4 score. It would be interesting to find out the correlations between computer anxiety with math achievement and math anxiety. Females were more prone to suffer from math anxiety. The relationship results may assist in alleviating some of the sex-inequality problems in computer related areas.

6. There was no difference between males and females who responded to the statement "males and females are equally capable of learning about computers". But more females agreed with "females are less likely to be encouraged to seek computer related jobs" (10.0% versus 8.59%). This result revealed that sex-role stereotyping does influence computer related fields.

7. From the results of analysis of variance and regression analyses, other than that of trait anxiety, the factors which affected the intensity of computer anxiety are situational transitory factors. This finding suggests that computer anxiety is reducible and removable, which is an encouraging finding, especially for educators.

Treatments such as the requiring of computer courses taken, improving math performance, encouragement from school board and parents will likely help to reduce computer anxiety and enhance the effectiveness of learning to use computers. However, other factors might exist. Further research using different theoretical entries are recommended.

8. Finally, the results of this study revealed that computer anxiety seemed to be a situation-dependent construct, which may be altered from time to time, depending upon the changes of social environment and implementation of computers. Therefore, there will be a need for continuous longitudinal studies about its occurrence, correlations, or effects in order to better understand this complex emotional psychological construct--COMPUTER ANXIETY.

Recommendations

After conducting a computer anxiety study, the following recommendations are proposed:

1. Repeated research is needed for two controversial findings in this study:

   (1) The negative correlation between trait anxiety and the disagreement of the computer's beneficial impacts toward an individual and society; and

   (2) The tendency for the computer related majors to possess more physiological reactions toward computers than other majors.

Samples controlled especially by major are necessary for the second repeated study.

2. Further research on computer anxiety model development is needed. Theoretical models which reflect other than the Computer-as-Process theory are recommended in order to identify potential computer anxiety variables from a different point of view and facilitate a more concise understanding of computer anxiety.
3. Research on the development of a computer anxiety measure is needed. Measurement is the critical part of a research study. Applied research depends to a major extent on the validity and reliability of the measurement used. There are currently only a few tentative computer anxiety instruments. None of them has been systematically tested and evaluated.
4. Research on correlates of computer anxiety is needed. Trait anxiety has been found in this study to be moderately correlated with computer anxiety. State anxiety, math anxiety, tool anxiety, high-tech anxiety, computer achievement, and math achievement are some other possible correlates. The results of correlational studies will not only enhance the understanding of the nature and occurrence of computer anxiety but also offer valuable information for the design of computer curricula and the prevention of computer anxiety.
5. Research on variables contributing to the difference of computer anxiety is neesed.

Although some significant variables have been identified from this study, on the whole, those variables explain less than 50% of variation of computer anxiety. Other factors needs to be included in future studies in order to develop a best-fit predictive equation for computer anxiety. The predictions of computer anxiety may be useful in career guidance and computer instruction.

6. More important, research on the management of computer anxiety is needed.

The terminal purpose of identifying or understanding the nature and characteristics of computer anxiety is to reduce personal suffering. One of the most important features of computer anxiety identified in this study was that, computer anxiety is situation-dependent and reducible or removable. A special training, treatments, or course design may contribute to the reduction of the computer anxiety. Research on this area is essential and crucial.

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APPENDIX A. COMPUTER ANXIETY INSTRUMENT (VERSION I)

This instrument is designed to differentiate persons who have anxiety toward computers versus persons who don't. Items which were developed based on Spielberger's "Anxiety-as-Process" theory reflect a person's reactions toward computers in five dimensions--cognitive, affective, behavioral, physiological and other influences or experiences. Spielberger implied anxiety as a complex emotional process which is a sequence of cognitive, affective, physiological and behavioral events that may be initiated by a stressful external stimulus or or by an internal cue that is perceived or interpreted as dangerous or threatening to an individual.

As an expert in the area of computer application, psychology and/or measurement would you assist me to evaluate this instrument? The tentative population for testing includes persons who are fifteen years old or older. Students in senior high, college and graduate school will be selected as representative subjects in this study.

Items displayed on the following pages include four parts. Part I measures the feelings or reactions of an individual toward the use or learning of computers, that is, the measurement of computer anxiety. Part II, Part III and Part IV ask an individual how s/he thinks about computers, the reasons why s/he does not use computers, and some demographic information in order to examine the relationship between computer anxiety and personal characteristics and/or experiences.

Please circle A, B, C, D, or E to indicate the degree of anxiety and Y or N to evaluate the appropriateness of each item, also fill free to edit the demographic questions.

The scale used:

```
    A        B        C        D        E            Y      N
    I--------I--------I--------I--------I            Yes    No
   low             nuetral            high           Appropriateness
 anxiety                             anxiety
```

Part I. Feelings or reactions toward the using or learning of computers.

.Computers will not be important to me.	A B C D E	Y N
.I usually have been at ease during occasions when computers were involved.	A B C D E	Y N
.Computer is facinating and fun.	A B C D E	Y N
.I (will) take a computer as a handy tool for my life.	A B C D E	Y N
.I probably feel more frustrated using a computer than other people.	A B C D E	Y N
.I prefer to stay away from computers.	A B C D E	Y N
.Computer terminology sounds like confusing jargon to me.	A B C D E	Y N
.I feel more confident in taking a paper-pencil test than answering questions through a computer.	A B C D E	Y N
.I feel confident about my ability to deal with computers.	A B C D E	Y N
.I would try to get involved in anything connected with computes.	A B C D E	Y N
.If given an opportunity to use a computer, I am afraid I might damage it in some way.	A B C D E	Y N
.I will be able to keep up with the important technological advances of computers.	A B C D E	Y N
.I (will be) am proud of knowing how to use computers.	A B C D E	Y N
.I would rather have someone do computer jobs for me than work it by myself.	A B C D E	Y N
.I would enjoy having a home computer.	A B C D E	Y N

.Computers make me feel helpless. A B C D E Y N

.I am worried that lack of a sufficient background about computers will prevent me from learning computers successfully. A B C D E Y N

.Computers make me feel impatient. A B C D E Y N

.I feel a sense of insecurity when attempting to use a computer. A B C D E Y N

.Even though I try hard, computers seem unusually hard for me. A B C D E Y N

.I am not the type of person who does well with computers. A B C D E Y N

.I feel apprehensive about using a computer. A B C D E Y N

.I wish I were living back in the days when there were no computers. A B C D E Y N

.Computers make me feel so stupid. A B C D E Y N

.I get a sinking feeling when I think that, no matter what, I have to learn/use computers. A B C D E Y N

.I worry about being able to give the computer a right command to follow. A B C D E Y N

.Computers do not scare me at all. A B C D E Y N

.I do not really care if I can not use computers. A B C D E Y N

.I found it difficult to admit that I do not know how to deal with an error message from computers. A B C D E Y N

.I like computers that save me a lot of time and effort, even it takes time to get familiar with system operation and commands in the beginning. A B C D E Y N

.If given an opportunity, I would like to use and learn about computers A B C D E Y N

.I would like to play games on a computer. A B C D E Y N

.I (will) avoid certain classes/jobs because of the use of computers. A B C D E Y N

.I encourage everyone to experiment with computers. A B C D E Y N

.When I hear the word "computer", I have a feeling of dislike. A B C D E Y N

.If available, I would choose computer related work over others as my future job. A B C D E Y N

.I am looking forward to the time when computers are in all homes. A B C D E Y N

.Computers make me feel uneasy and confused. A B C D E Y N

.I do as little work with a computer as possible. A B C D E Y N

.I would rather type a letter by useing a typewriter than a word processor on computers. A B C D E Y N

Please move to Part II, if you never personally worked with a computer.

.I cannot keep my mind on work while operating a computer. A B C D E Y N

.I would not be worried about my capability of debugging any computer error. A B C D E Y N

.I would feel calm and collected while someone observed me working with a computer. A B C D E Y N

.I notice my heart pounding when I am asked to finish some jobs on computers. A B C D E Y N

.I feel useless when I sit before a computer. A B C D E Y N

.The prompt feedback from computers is somewhat exciting. A B C D E Y N

.I perform normally while using a computer just like I usually do with other tools. A B C D E Y N

.Once I start to work with a computer, I find it hard to stop. A B C D E Y N

.I sweat very easily when manipulating a computer.	A	B	C	D	E	Y	N
.When I get into a computer problem that I can not figure out immediately, I stick with it until I have the solution.	A	B	C	D	E	Y	N
.I enjoy the challenge of figuring out how a computer program works.	A	B	C	D	E	Y	N
.Computers make me feel as though I am lost in a jungle of "commands" and can not find my way out.	A	B	C	D	E	Y	N
.My mind goes blank, and I am unable to think clearly when working with computers.	A	B	C	D	E	Y	N
.I enjoy showing someone else how to use a computer.	A	B	C	D	E	Y	N
.I feel calm and collected even when computers give me a lot of error messages.	A	B	C	D	E	Y	N
.I frequently notice my hand shakes when I attempt to manipulate computers.	A	B	C	D	E	Y	N
.I notice I become short of breath when I am asked to do something on computers.	A	B	C	D	E	Y	N

Part II. Beliefs about computers

	Appropriateness	
.People would respect a person more if s/he was really handy in using computers.	Y	N
.Computer technology is creating a lot more unhappiness among people than the help it provides.	Y	N
.Computers slow down and complicate simple business operations.	Y	N
.Our country relies too much on computers.	Y	N
.Computers offer unlimited possibility for everyone.	Y	N
.Few people have experienced using computers successfully.	Y	N
.Computers are valuable educational tools.	Y	N
.Even if a person does not know any computer language, s/he can still use computers.	Y	N
.Children should be introduced to computers.	Y	N
.Everyone should be willing to give computers a try.	Y	N
.A person today cannot escape the influence of computers.	Y	N
.A computer is a tool, just like a hammer or a calculator.	Y	N
.Our country would be better off if there were no computers.	Y	N
.Although computers eliminate many jobs, they create many other new ones.	Y	N
.Computers isolate people by preventing normal social interaction among users.	Y	N
.In today's world, everyone should know how to use computers in some way.	Y	N
.Computers are beneficial aids to a modern society.	Y	N
.Computers have no place in the classroom.	Y	N
.I worry about the bad consequences of putting computers in schools.	Y	N
.School wide emphasis on experimenting with computers should be encouraged.	Y	N
.Computers are too complicated for the average person to use.	Y	N
.Learning computers is a waste of time.	Y	N
.A person who has not been exposed to computers will be at a disadvantage when competing with those who have.	Y	N

Part III. Reasons for not using computers

	Appropriateness	
.I hesitate to use a computer for fear of making mistakes that I can not correct.	Y	N
.I do not like to use computers because of the typing skill required.	Y	N
.I have avoided computers because they are unfamiliar to me.	Y	N
.I do not like the idea of computers replacing the human skills.	Y	N
.Computers are frustrating because they break down so often.	Y	N
.I do not play with computers because the computer is too expensive to buy.	Y	N
.I have difficulty using a computer because computers are too complicated.	Y	N
.I do not like computers because they may take over my job someday.	Y	N
.I do not like to use computers because of the mathematics required.	Y	N
.I do not like to use computers because the computers are humanless.	Y	N
.I feel nervous with computers because I have to use a computer in a public place.	Y	N

Part IV. Demographic information

Your current age in years ______________
Your educational level:
__ junior high __ senior high __ college/university __ graduate school
Your sex:
__ male __ female
Your major (or intentive major)___________________________________
The computer courses you have taken: (Please put down the total credits in the following related areas. If your credits are quarter credits, please specify.)
__ Computer literacy (introduction to computers)
__ Computer operations
__ Business data processing
__ Computer applications (spread sheets, word processing, database management,...)
__ Computer applications (computer aided instruction, computer aided design/graphics, statistical analysis package, SAS, SPSSX, BMDP,...)
__ Computer programing language (BASIC, FORTRAN, PASCAL, COBEL,...)
__ Computer machine level programing/language (Assembling, C language,...)
__ Computational structures
__ Computer operating systems
__ Computer simulation
Your computer experience: (select the one which most appropriately describes you)
__ I have no experience with a computer.
__ I have used a computer printout produced by someone else.
__ I have personally worked with a computer by playing computer games.
__ I have personally worked with a computer by inputing research or business information for processing.
__ I have personally construct the program statements for running packaged programs.
__ I have personally develop a computer program.
__ I am proficient in one or more computer languages.
__ I ever earned money with my knowledge of computer software or hardware.
Do you have a personal computer at home?
__ yes __ no

Do you like mathematics?
__ Very much   __ Like   __ So-so
__ Dislike   __ Definitely dislike

Estimate your overall mathematics grade?
__ 3.6 to 4.0 (A- to A)   __ 1.6 to 2.0 (C- to C)
__ 3.1 to 3.5 (B to B+)   __ 1.0 to 1.5 (D to D+)
__ 2.6 to 3.0 (B- to B)   __ Less than 1.0
__ 2.1 to 2.5 (C to C+)

Male and female are equally good in learning computers.
__ Agree   __ Disagree   __ Uncertain

Females who like to work on computers are viewed as a little strange.
__ Agree   __ Disagree   __ Uncertain

Your father's occupation ______________________________

Your father's educational level ________________________

What is your father's attitude toward your learning or use of computers?
__ Strongly encourage   __ Encourage   __ Don't care
__ Discourage   __ Strongly discourage

What is your father's attitude toward computers?
__ Strongly approve   __ Approve   __ Neutral
__ Object   __ Strongle object   __ Don't know

Your mother's occupation ______________________________

Your mother's educational level ________________________

What is your mother's attitude toward your learning or use of computers?
__ Strongly encourage   __ Encourage   __ Don't care
__ Discourage   __ Strongly discourage

What is your mother's attitude toward computers?
__ Strongly approve   __ Approve   __ Neutral
__ Object   __ Strongle object   __ Don't know

How does the climate of your school affect your learning or use of computers?
__ Strongly encourage   __ Encourage   __ No influence
__ Discourage   __ Strongly discourage

Followings are statements which people have used to describe themselves in general. Select the answer which is most applropriate apply to you in each each statement.

	Appropriateness	
.I can not sit in a chair for very long.	Y	N
.I feel anxious about new things or strangers.	Y	N
.I am calm and not easily upset.	Y	N
.I am nervous.	Y	N
.I feel embarrassed learning about new equipment in front of others.	Y	N
.I find it hard to keep my mind on a task or a job.	Y	N
.I feel nervous when I am being observed by anybody.	Y	N
.I do not like to face a challege or make a decision by myself.	Y	N
.I find myself worrying about something.	Y	N

APPENDIX B. COMPUTER ANXIETY INSTRUMENT (JUDGES' VERSION)

Directions

This instrument is designed to provide you the opportunity to express your feelings toward computers. There are no right or wrong responses, so do not hesitate to respond the statements frankly. You will notice that there is no place for your name. Please do not record your name.

Part I. Background Information
Questions in this part ask some information about you, your parents, and your school. These questions are included not to indentify anyone but to relate the answers to other items in this instrument. Please fill out every question.

About yourself:
Your current age in years: ______________
Your educational level:
__ junior high __ senior high __ 2-year community college
__ 4-year college/university __ graduate school
Your sex:
__ male __ female
Your major (or intended major): ________________________________
The computer courses you have taken: (Please put down the total credits you took in each related area. If your credits are quarter credits, please specify.)
__ Computer literacy (introduction to computers)
__ Computer operations (keypunch operations and other peripheral equipment operations)
__ Business data processing
__ Computer applications (spread sheets, word processing, database management,...)
__ Computer applications (computer aided instruction, computer aided design/graphics, statistical analysis package, SAS, SPSSX, BMDP,...)
__ Computer programing language (BASIC, FORTRAN, PASCAL, COBOL,...)
__ Computer machine level programing/language (Assembly, C language,...)
__ Computer data structures
__ Computer operating systems
__ Computer organization and design
__ Others (____)
Your computer experience: (Select the statement(s) which most appropriately describes you. You may select more than one.)
__ I have no experience with a computer.
__ I have used a computer printout produced by someone else.
__ I have personally worked with a computer by playing computer games.
__ I have personally worked with a computer by inputting research or business information for processing.
__ I have personally constructed the program statements for running packaged programs.
__ I have personally developed a computer program.
__ I am proficient in one or more computer languages.
__ I have earned money with my knowledge of computer software or hardware.
Do you have a personal computer at home?
__ yes __ no
Do you like mathematics?
__ Like very much __ Like __ So-so
__ Dislike __ Definitely dislike
Estimate your overall grade in mathematics:
__ 3.6 to 4.0 (A- to A) __ 1.6 to 2.0 (C- to C)
__ 3.1 to 3.5 (B to B+) __ 1.0 to 1.5 (D to D+)
__ 2.6 to 3.0 (B- to B) __ Less than 1.0
__ 2.1 to 2.5 (C to C+)
Do you agree that males and females are equally good in learning computers?
__ Agree __ Disagree __ Uncertain
Do you agree that females who like to work on computers are viewed as a little strange.
__ Agree __ Disagree __ Uncertain

Directions for Judges

This instrument is designed to differentiate between persons have high degree of computer anxiety and who don't have. Items displayed include four parts. Part II measures the feelings or reactions of an individual toward the use or learning of computers, that is, the measurement of computer anxiety. Part I, III, and IV ask an individual how s/he thinks about computers, and some background information in order to examine the relationship between computer anxiety and personal characteristics and/or experiences.

Would you read statements in Part II and Part III, then circle your rating of each statement. Please answer the following questions before you move to Part II or Part III.

Your sex:
__ male __ female

Your educational level:
____

Your major/intended major/ occupation:
____

Followings are statements which people have used to describe themselves in general. Circle the 'Y' if the statement is true about you. Circle the 'N' if the statement is not true about you.

1.	I cannot sit in a chair for very long.	Y	N
2.	I feel anxious about new things or strangers.	Y	N
3.	I am not easily upset.	Y	N
4.	I am a nervous person.	Y	N
5.	I feel embarrassed learning about new equipment in front of others.	Y	N
6.	I find it hard to keep my mind on a task or a job.	Y	N
7.	I feel nervous when I am being observed by anybody.	Y	N
8.	I do not like to face a challenge or make a decision by myself.	Y	N
9.	I usually find myself worrying about something.	Y	N

About your parents and school:

Your father's occupation: ______________________________

Your father's educational level: ______________________________

What is your father's attitude toward your learning or use of computers?

__ Strongly encourage   __ Encourage   __ Neutral
__ Discourage   __ Strongly discourage   __ Don't care

What is your father's attitude toward computers?

__ Strongly approve   __ Approve   __ Neutral
__ Object   __ Strongly object   __ Don't know

Your mother's occupation: ______________________________

Your mother's educational level: ______________________________

What is your mother's attitude toward your learning or use of computers?

__ Strongly encourage   __ Encourage   __ Neutral
__ Discourage   __ Strongly discourage   __ Don't care

What is your mother's attitude toward computers?

__ Strongly approve   __ Approve   __ Neutral
__ Object   __ Strongly object   __ Don't know

How does the climate of your school affect your learning or use of computers?

__ Strongly encourage   __ Encourage   __ No influence
__ Discourage   __ Strongly discourage

Following three parts of the instrument are designed for machine scoring. Read each statement carefully, then mark down your answer on appropriate circle on the computer answer sheet.

Use Scale:
A--strongly agree
B--agree
C--uncertain
D--disagree
E--strongly disagree

Please
(1) Use a soft lead pencil.
(2) Make heavy black marks that fill the circle.
(3) Erase cleanly any answer you wish to change.

Use Scale: A--strongly agree
B--agree
C--uncertain
D--disagree
E--strongly disagree

Part II. Feelings or reactions toward the learning or use of computers.

1. I usually have been at ease during occasions when computers were involved. A B C D E
2. I get a sinking feeling when I think that, no matter what, I have to learn/use computers. A B C D E
3. Computers are fascinating and fun. A B C D E
4. I view computers as handy tools in my life. A B C D E
5. I probably feel more frustrated in attempting to use a computer than other people do. A B C D E
6. I prefer to stay away from computers. A B C D E
7. I rather take a paper-pencil test than answer questions through a computer. A B C D E
8. I feel confident about my ability to deal with computers. A B C D E
9. I (will be) am proud of knowing how to use computers. A B C D E
10. I am not the type of person who does well with computers. A B C D E
11. I (would) enjoy having a home computer. A B C D E
12. Computers make me feel helpless. A B C D E
13. I feel a sense of insecurity when attempting to use a computer. A B C D E
14. I feel apprehensive about using a computer. A B C D E
15. Computers make me feel so stupid. A B C D E
16. Computers do not scare me at all. A B C D E
17. If given an opportunity, I would like to use and learn about computers. A B C D E
18. I (will) avoid certain classes/jobs because of the use of computers. A B C D E
19. When I hear the word "computer", I have a feeling of dislike. A B C D E
20. If available, I would choose computer related work over others as my future job. A B C D E
21. Computers make me feel impatient. A B C D E
22. I am looking forward to the time when computers are in all homes. A B C D E
23. Computers make me feel uneasy and confused. A B C D E

Please move to Part III, if you never personally worked with a computer.

24. I find it difficult to keep my mind on work while operating a computer. A B C D E
25. I (would) feel calm and collected while someone observed me working with a computer. A B C D E
26. I notice my heart pounding when I am asked to finish some jobs on computers. A B C D E
27. I feel useless when I sit before a computer. A B C D E
28. The prompt feedback from computers is somewhat exciting. A B C D E
29. I perform normally while using a computer just like I usually do with other tools. A B C D E
30. Once I start to work with a computer, I find it hard to stop. A B C D E
31. I sweat very easily when manipulating a computer. A B C D E

Part II. Directions for Judges

Please circle A, B, C, D, or E right after each statement to indicate the degree of anxiety a person would have if s/he agrees with the statement.

Use scale:

```
A      B      C      D      E
|------|------|------|------|
low        neutral       high
anxiety                anxiety
```

Use Scale: A--strongly agree
B--agree
C--uncertain
D--disagree
E--strongly disagree

32. When I get into a computer problem that I cannot figure out immediately, I stick with it until I have the solution. A B C D E
33. I notice I become short of breath when I am asked to do something on computers. A B C D E
34. I enjoy the challenge of figuring out how a computer program works. A B C D E
35. Computers make me feel as though I am lost in a jungle of "commands" and cannot find my way out. A B C D E
36. Sometimes my mind goes blank, and I am unable to think clearly when working with computers. A B C D E
37. I enjoy showing someone else how to use a computer. A B C D E
38. I feel calm and collected even when computers give me a lot of error messages. A B C D E
39. I frequently notice my hand shakes when I attempt to manipulate computers. A B C D E

Use scale:

```
A     B     C     D     E
|-----|-----|-----|-----|
low       neutral    high
anxiety             anxiety
```

Part III. Attitude toward computers

1. People would respect a person more if s/he was really handy in using computers. A B C D E
2. Computer technology is creating a lot more unhappiness among people than the help it provides. A B C D E
3. Computers slow down and complicate simple business operations. A B C D E
4. Our country relies too much on computers. A B C D E
5. Computers are valuable educational tools. A B C D E
6. Even if a person does not know any computer language, s/he can still use computers. A B C D E
7. Computers isolate people by preventing normal social interaction among users. A B C D E
8. Children should be introduced to computers. A B C D E
9. Everyone should be willing to give computers a try. A B C D E
10. A person today cannot escape the influence of computers. A B C D E
11. A computer is a tool, similar to a hammer or a calculator. A B C D E
12. Our country would be better off if there were no computers. A B C D E
13. In today's world, everyone should know how to use computers in some way. A B C D E
14. Computers are beneficial aids to a modern society. A B C D E
15. Computers have no place in the classroom. A B C D E
16. I worry about the bad consequences of putting computers in schools. A B C D E
17. School wide emphasis on experimenting with computers should be encouraged. A B C D E
18. Computers are too complicated for the average person to use. A B C D E
19. Learning computers is a waste of time. A B C D E
20. A person who has not been exposed to computers will be at a disadvantage when competing with those who have. A B C D E

Part III. Directions for Judges

Please circle A, B, C, D, or E right after each statement to indicate the attitude a person would have toward computers if s/he agrees with the statement.

Use scale:

```
A     B     C     D     E
|-----|-----|-----|-----|
very      neutral     very
positive          negative
attitude          attitude
```

Use Scale: A--strongly agree
B--agree
C--uncertain
D--disagree
E--strongly disagree

Part IV. Reasons for not using computers

1. I hesitate to use a computer for fear of making mistakes that I cannot correct.	A	B	C	D	E
2. I do not like to use computers because of the typing skill required.	A	B	C	D	E
3. I have avoided computers because they are unfamiliar to me.	A	B	C	D	E
4. I do not like the idea of computers replacing the human skills.	A	B	C	D	E
5. I try not to use computers because they break down so often.	A	B	C	D	E
6. I do not play with computers because they are too expensive to buy.	A	B	C	D	E
7. I have difficulty using a computer because computers are too complicated.	A	B	C	D	E
8. I have avoided to use computers because the radiation may hurt me.	A	B	C	D	E
9. I do not like computers because they may take over my job someday.	A	B	C	D	E
10. I feel nervous with computers because I have to use a computer in a public place.	A	B	C	D	E
11. I do not like to use computers because the computers are impersonal.	A	B	C	D	E
12. I hesitate to use a computer for fear of damaging the computer in some way.	A	B	C	D	E
13. I do not like to use computers because I have to spend a lot of time to get familiar with computer commands and system operations first.	A	B	C	D	E
14. I have avoided computers because I have some failure experiences with computers.	A	B	C	D	E
15. I hesitate to use a computer for fear of straining my eyes.	A	B	C	D	E
16. I do not like to use computers because of the mathematics required.	A	B	C	D	E

Other reasons: (Please specify)

______________________________	A	B	C	D	E
______________________________	A	B	C	D	E
______________________________	A	B	C	D	E

Please return: Li-Zung Lin
B3 Industrial Education Building II
Iowa State University
Ames, IA 50011

Part IV. Directions for Judges

Please stop here. Thank you for your assistance.

APPENDIX C. COMPUTER ANXIETY INSTRUMENT (PILOT STUDY VERSION)

Directions

This instrument is designed to provide you the opportunity to express your feeling toward computers. There are no right or wrong responses, so do not hesitate to respond the statements frankly. Please do not put your name on the instrument.

Part I. Background information
Questions in this part ask some information about you, your parents, and your school. These questions are included to relate the answers to other items in this instrument. Please answer every question.

About yourself:

Your current age in years: ______________

Your current educational status:
__ a junior high student __ a senior high student
__ a 2-year community college student
__ a 4-year college/university student
__ a graduate student

Your sex:
__ male __ female

Your major (or intended major): ______________________________

The computer courses you have taken: (Please put down the total credits you took in each related area. If your credits are quarter credits, please specify.)
__ Computer literacy (introduction to computers)
__ Computer operations (keypunch operations and other peripheral equipment operations)
__ Business data processing
__ Computer applications (spread sheets, word processing, database management,...)
__ Computer applications (computer aided instruction, computer aided design/graphics, statistical analysis package, SAS, SPSSX, BMDP,...)
__ Computer programing language (BASIC, FORTRAN, PASCAL, COBOL,...)
__ Computer machine level programing/language (Assembly, C language,...)
__ Computer data structures
__ Computer operating systems
__ Computer organization and design
__ Others (______________________________)

Your computer experience: (Select the statement(s) which most appropriately describes you. You may select more than one.)
__ I have no experience with a computer.
__ I have used a computer printout produced by someone else.
__ I have personally worked with a computer by playing computer games.
__ I have personally worked with a computer by inputting research or business information for processing.
__ I have personally constructed the program statements for running packaged programs.
__ I have personally developed a computer program.
__ I am proficient in one or more computer languages.
__ I have earned money with my knowledge of computer software or hardware.

Do you have a personal computer at home?
__ yes __ no

Do you like mathematics?
__ Like very much __ Like __ So-so
__ Dislike __ Definitely dislike

Estimate your overall mathematics ability:
__ far above average __ above average
__ average
__ below average __ far below average

Do you agree that males and females are equally capable in learning about computers?
__ Agree __ Disagree __ Uncertain

Do you agree that females who like to work on computers are viewed as a little strange.
__ Agree __ Disagree __ Uncertain

Followings are statements which people have used to describe themselves in general. Circle the 'Y' if the statement is true about you. Circle the 'N' if the statement is not true about you.

1.	I cannot sit in a chair for very long.	Y	N
2.	I feel anxious about new things or strangers.	Y	N
3.	I am not easily upset.	Y	N
4.	I am a nervous person.	Y	N
5.	I feel embarrassed learning about new equipment in front of others.	Y	N
6.	I find it hard to keep my mind on a task or a job.	Y	N
7.	I feel nervous when I am being observed by anybody.	Y	N
8.	I do not like to face a challenge or make a decision by myself.	Y	N
9.	I usually find myself worrying about something.	Y	N

About your parents and school:

Your father's occupation: ____________________

Your father's educational level: ____________________

What is your father's attitude toward your learning or use of computers?
__ Strongly encourage __ Encourage __ Neutral
__ Discourage __ Strongly discourage __ Don't care

What is your father's attitude toward computers?
__ Strongly approve __ Approve __ Neutral
__ Object __ Strongly object __ Don't know

Your mother's occupation: ____________________

Your mother's educational level: ____________________

What is your mother's attitude toward your learning or use of computers?
__ Strongly encourage __ Encourage __ Neutral
__ Discourage __ Strongly discourage __ Don't care

What is your mother's attitude toward computers?
__ Strongly approve __ Approve __ Neutral
__ Object __ Strongly object __ Don't know

How does the climate of your school affect your learning or use of computers?
__ Strongly encourage __ Encourage __ No influence
__ Discourage __ Strongly discourage

Following three parts of the instrument are designed for machine scoring. Read each statement carefully, then mark down your answer on appropriate circle on the computer answer sheet.

Use Scale: A--strongly agree
B--agree
C--uncertain
D--disagree
E--strongly disagree

Please (1) Use a soft lead pencil.
(2) Make heavy black marks that fill the circle.
(3) Erase cleanly any answer you wish to change.

Part II. Feelings or reactions toward the learning or use of computers.

1. I usually have been at ease during occasions when computers were involved.
2. I get a sinking feeling when I think that, no matter what, I have to learn/use computers.
3. Computers are fascinating and fun.
4. I view computers as handy tools in my life.
5. I probably feel more frustrated in attempting to use a computer than other people do.
6. I prefer to stay away from computers.
7. I would rather take a paper-pencil test than answer questions through a computer.
8. I feel confident about my ability to deal with computers.
9. I am (will be) proud of knowing how to use computers.
10. I am not the type of person who does well with computers.
11. I (would) enjoy having a home computer.
12. Computers make me feel helpless.
13. I feel a sense of insecurity when attempting to use a computer.
14. I feel apprehensive about using a computer.
15. Computers make me feel so stupid.
16. Computers do not scare me at all.
17. If given an opportunity, I would like to use and learn about computers.
18. I (will) avoid certain classes/jobs because of the use of computers.
19. When I hear the word "computer", I have a feeling of dislike.
20. If available, I would choose computer related work over other possibilities as my future job.
21. Computers make me feel impatient.
22. I am looking forward to the time when computers are in all homes.
23. Computers make me feel uneasy and confused.

Please move to Part III, if you never personally worked with a computer.

24. I find it difficult to keep my mind on my work while operating a computer.
25. I (would) feel calm and collected while someone observed me working with a computer.
26. I notice my heart pounding when I am asked to finish some jobs on computers.
27. I feel useless when I sit before a computer.
28. The prompt feedback from computers is somewhat exciting.
29. I perform normally while using a computer just like I usually do with other tools.
30. Once I start to work with a computer, I find it hard to stop.
31. I sweat very easily when manipulating a computer.
32. When I get into a computer problem that I cannot figure out immediately, I stick with it until I have the solution.
33. I notice I become short of breath when I am asked to do something on computers.
34. I enjoy the challenge of figuring out how a computer program works.
35. Computers make me feel as though I am lost in a jungle of "commands" and cannot find my way out.
36. Sometimes my mind goes blank, and I am unable to think clearly when working with computers.
37. I enjoy showing someone else how to use a computer.
38. I feel calm and collected even when the computer give me a lot of error messages.
39. I frequently notice my hand shakes when I attempt to work on a computer.

Use Scale: A--strongly agree
B--agree
C--uncertain
D--disagree
E--strongly disagree

Part III. Attitude toward computers

40. People would respect a person more if s/he were really handy in using computers.
41. Computer technology is creating a lot more unhappiness among people than the help it provides.
42. Computers slow down and complicate simple business operations.
43. Our country relies too much on computers.
44. Computers are valuable educational tools.
45. Even if a person does not know any computer language, s/he can still use computers.
46. Computers isolate people by preventing normal social interactions.
47. Children should be introduced to computers.
48. Everyone should be willing to give computers a try.
49. A person today cannot escape the influence of computers.
50. A computer is a tool, similar to a hammer or a calculator.
51. Our country would be better off if there were no computers.
52. In today's world, everyone should know how to use computers in some way.
53. Computers are beneficial aids to a modern society.
54. Computers have no place in the classroom.
55. I worry about the negative consequences of putting computers in schools.
56. School wide emphasis on experimenting with computers should be encouraged.
57. Computers are too complicated for the average person to use.
58. Learning about computers is a waste of time.
59. A person who has not been exposed to computers will be at a disadvantage with those who have.

Part IV. Reasons for not using computers

60. I hesitate to use a computer for fear of making mistakes that I cannot not correct.
61. I do not like to use computers because of the typing skill required.
62. I have avoided computers because they are unfamiliar to me.
63. I do not like the idea of computers replacing human skills.
64. I try not to use computers because they break down so often.
65. I do not play with computers because they are too expensive to buy.
66. I have difficulty using a computer because computers are too complicated.
67. I have avoided to use computers because the radiation may hurt me.
68. I do not like computers because they may take over my job someday.
69. I feel nervous with computers because I have to use a computer in a public place.
70. I do not like to use computers because they are impersonal.
71. I hesitate to use a computer for fear of damaging the computer in some way.
72. I do not like to use computers because I have to spend a lot of time to get familiar with computer commands and system operations first.
73. I have avoided computers because I have had some failure experiences with computers.
74. I hesitate to use a computer for fear of straining my eyes.
75. I do not like to use computers because of the mathematics requires.

Other reasons: (Please specify)

76. ____________________

77. ____________________

78. ____________________

Do you feel the size of letters are too small to read?
___ Yes ___ No

Please return to: Li-Zung Lin
B3 Industrial Education Building II
Iowa State University
Ames, IA 50011

** Thank you very much for your assistance! **

APPENDIX D. INVITATION LETTER

College of Education
Department of Industrial
Education and Technology
Ames. Iowa 50011

IOWA STATE
UNIVERSITY

Telephone: 515-294-1033

A study is being conducted at Iowa State University to develop a computer anxiety instrument and identify those aspects which affect the inducement of anxiety toward computers. I am asking for your assistance to help me to complete this study.

With the rapid development of technology, computers have become useful tools in industries, business and schools. However, many people have found themselves to be fearful of, or anxious about computers especially at the beginning. Although there are many articles which discussed the phenomena of computer anxiety, seldom have put efforts into examining the factors which contribute to the arousal of computer anxiety. A belief that a knowledge of such factors could have four major values prompts this study. (1) The findings could aid to understand deeply the nature and occurrence of computer anxiety. (2) The understanding of computer anxiety could aid to identify the types of people particularly in need of help in learning or using computers. (3) The understanding of computer anxiety could be useful in the design of computer curricula or programs for computer anxiety prevention or treatment. (4) The awareness of computer anxiety will help individuals to adjust to today's computerized society.

Samples in this study will include students with or without computer experiences from high school through graduate school level. However, it would be better to have some students with some experiences and other students have little or no experience. Each sample will be asked to fill out a 30-minute long questionnaire which includes feelings about computers, attitudes toward computers, and some background information. The responses will be scanned by a computer and summarized as group results. Neither schools nor individuals will be identified. Complete confidentiality will be maintained throughout the study.

If it is possible, I would like to have about one hundred of your students fill out my questionnaire within next month. However, the date and the number of the students can be arranged at your most convenience. Please let me know if you are willing to have your students participate in this study. I can be reached at (515) 294-6775 or 294-5471. Your assistance is greatly appreciated.

We are looking forward to your early reply.

Sincerely yours,

William D. Wolansky
William D. Wolansky
Coordinator
International Educational Program
Professor
Industrial Education & Technology
Iowa State University

Li-Zung Lin
Doctoral Candidate
Industrial Education & Technology
Iowa State University

A copy of questionnaire is attached for your reference.

APPENDIX E. LETTER FOR CONTACT PERSON

College of Education
Department of Industrial
Education and Technology
Ames, Iowa 50011

IOWA STATE
UNIVERSITY

Telephone: 515-294-1033

Here comes my questionnaire!

Enclosed are ______ copies of the questionnaires and computer answer sheets, cover letter, procedure of distributing and collecting questionnaires, and a Business Reply Mail label. Please follow the procedure to distribute and collect the questionnaires.

The respondents will be asked to put down the first four answers on their questionnaires and the rest of the answers on separate computer answer sheets. ID number is assigned to match the separate answers. Please do check whether everyone copied down his/her ID number to the computer answer sheet. The Business Reply Mail label is for your convenience to send the package back. Use it just like an address label. Please call me at (515) 294-6775 am, or 294-5471 pm if you have any question. Your assistance is highly appreciated.

Would you let me know if you like to have a copy of research results. I will be very happy to share with you the findings.

Sincerely yours,

Li-Zung Lin

P.S. Would you give me a written statement which indicate that you are willing to participate in the survey? The Human Subject Committee at ISU ask an agreement letter from the instructor or principal from the high school level.

APPENDIX F. INSTRUCTIONS OF DATA DISTRIBUTION AND COLLECTION

THE PROCEDURE TO DISTRIBUTE AND COLLECT QUESTIONNAIRES

(1) Read the cover letter to respondents.

(2) Distribute questionnaires and computer answer sheets to the respondents.

(3) Remind the respondents to put down ID number (which is on the upper right corner of their questionnaires) on the IDENTIFICATION NUMBER columns of the computer answer sheet.

(4) Double check if the ID number is on the computer answer sheets while collecting the questionnaires.

(5) Use the Business Reply Mail label to send back the collected questionnaires.

Thank you very much for your assistance.

APPENDIX G. COVER LETTER FOR PARTICIPANT

IOWA STATE UNIVERSITY

College of Education
Department of Industrial
Education and Technology
Ames, Iowa 50011

Telephone: 515-294-1033

A study is being conducted at Iowa State University to develop a computer anxiety instrument and identify those aspects which affect the inducement of anxiety toward computers. I am inviting you to participate this study.

With the rapid development of technology, computers have become useful tools in industries, business and schools. However, many people have found themselves to be fearful of, or anxious about computers especially at the beginning. Although there are many articles which discussed the phenomena of computer anxiety, seldom have put efforts into examining the factors which contribute to the arousal of computer anxiety. A belief that a knowledge of such factors could have four major values prompts this study. (1) The findings could aid to understand deeply the nature and occurrence of computer anxiety. (2) The understanding of computer anxiety could aid to identify the types of people particularly in need of help in learning or using computers. (3) The understanding of computer anxiety could be useful in the design of computer curricula or programs for computer anxiety prevention or treatment. (4) The awareness of computer anxiety will help individuals to adjust to today's computerized society.

Please take the time to fill out this questionnaire and return it to your instructor or by mail in the envelope provided. Your responses will be scanned by a computer and summarized as group results. No individual responses will be referred. Complete confidentiality will be maintained throughout the study.

We appreciate the time and effort you will spend on this questionnaire.

Sincerely yours,

William Wolansky

William D. Wolansky
Coordinator
International Educational Program
Professor
Industrial Education & Technology
Iowa State University

Li-zung Lin

Li-Zung Lin
Doctoral Candidate
Industrial Education & Technology
Iowa State University

APPENDIX H. COMPUTER ANXIETY INSTRUMENT (FIELD TEST VERSION)

ID: ______________

Directions

This instrument is designed to provide you the opportunity to express your feeling toward computers. There are no right or wrong responses, so do not hesitate to respond the statements frankly. Please do not put your name on the instrument.

Part I. Background information
Questions in this part ask some information about you, your parents, and your school. These questions are included to relate the answers to other items in this instrument. Please answer every question.

About yourself:

Your current age in years: ______________

Your major (or intended major). For high school student, put down the course which you are most interested in: ______________________________

The computer courses you have taken: (Please put down the total credits you took in each related area. If your credits are quarter credits, please specify.)
__ Computer literacy (introduction to computers)
__ Computer operations (keypunch operations and other peripheral equipment operations)
__ Business data processing
__ Computer applications (spread sheets, word processing, database management,...)
__ Computer applications (computer aided instruction, computer aided design/graphics, statistical analysis package, SAS, SPSSX, BMDP,...)
__ Computer programing language (BASIC, FORTRAN, PASCAL, COBOL,...)
__ Computer machine level programing/language (Assembly, C language,...)
__ Computer data structures
__ Computer operating systems
__ Computer organization and design
__ Others (______________________________)

Your computer experience: (Select the statement(s) which most appropriately describes you. You may select more than one.)
__ I have no experience with a computer.
__ I have used a computer printout produced by someone else.
__ I have personally worked with a computer by playing computer games.
__ I have personally worked with a computer by inputting research or business information for processing.
__ I have personally constructed the program statements for running packaged programs.
__ I have personally developed a computer program.
__ I am proficient in one or more computer languages.
__ I have earned money with my knowledge of computer software or hardware.

What is your reason, if any, for not using or learning to use computers?

____

Following parts of the instrument are designed for machine scoring. Read each statement carefully, then mark down your answer in accordance with the item number on the separate COMPUTER ANSWER SHEET.

Please (1) Use a soft lead pencil.
(2) Make heavy black marks that fill the circle.
(3) Erase cleanly any answer you wish to change.

* Be sure to put down your ID number (which is on the right upper corner of this page) on the IDENTIFICATION NUMBER columns of your computer answer sheet. *

1. Your current educational status:
   A. a junior high student
   B. a senior high student
   C. a 2-year community college student
   D. a 4-year college/university student
   E. a graduate student

2. Your sex:
   A. Male B. Female

3. Do you have a personal computer at home?
   A. Yes B. No

4. Do you like mathematics?
   A. Like very much B. Like C. So-so
   D. Dislike E. Definitely dislike

5. Estimate your overall mathematics ability:
   A. Far above average B. Above average C. Average
   D. Below average E. Far below average

6. Males and females are equally capable in learning about computers.
   A. Agree B. Disagree C. Uncertain

7. Females are less likely to be encouraged to seek computer related jobs.
   A. Agree B. Disagree C. Uncertain

Item 8 through item 16 are statements which people have used to describe themselves in general. Mark the "A" (agree) if the statement is true about your. Mark the "D" (disagree) if the statement is not true about you.

8. I cannot sit in a chair for very long.
9. I feel anxious about new things or strangers.
10. I am not easily upset.
11. I am a nervous person.
12. I feel embarrassed learning about new equipment in front of others.
13. I find it hard to keep my mind on a task or a job.
14. I feel nervous when I am being observed by anybody.
15. I do not like to face a challenge or make a decision by myself.
16. I usually find myself worrying about something.

About your parents and school:

17. Does your father's job involve computers?
    A. Directly uses B. Indirectly uses
    C. Doesn't use D. Don't know

18. Your father's educational level:
    A. Some high school/finished high school
    B. Trade or business school/some college
    C. Finished 2-year college
    D. Finished 4-year college/university
    E. Attended graduate or professional school after college/university

19. What is your father's attitude toward your learning or use of computers?
    A. Strongly encourages B. Encourages C. Neutral
    D. Discourages E. Strongly discourages

20. What is your father's attitude toward computers?
    A. Strongly Approves B. Approves C. Neutral
    D. Objects E. Strongly objects

21. Does your mother's job involve computers?
    A. Directly uses B. Indirectly uses
    C. Doesn't use D. Don't know

22. Your mother's educational level:
    A. Some high school/finished high school
    B. Trade or business school/some college
    C. Finished 2-year college
    D. Finished 4-year college/university
    E. Attended graduate or professional school after college/university

23. What is your mother's attitude toward your learning or use of computers?
A. Strongly encourages B. Encourages C. Neutral
D. Discourages E. Strongly discourages

24. What is your mother's attitude toward computers?
A. Strongly Approves B. Approves C. Neutral
D. Objects E. Strongly objects

25. How does the climate of your school affect your learning or use of computers?
A. Strongly encourages B. Encourages C. No influence
D. Discourages E. Strongly discourages

Part II. Feelings or reactions toward the learning or use of computers.

Use
A--strongly agree
B--agree
C--uncertain
D--disagree
E--strongly disagree

26. I usually have been at ease during occasions when computers were involved.
27. I get a sinking feeling when I think that, no matter what, I have to learn/use computers.
28. Computers are fascinating and fun.
29. I view computers as handy tools in my life.
30. I probably feel more frustrated in attempting to use a computer than other people do.
31. I prefer to stay away from computers.
32. I would rather take a paper-pencil test than answer questions through a computer.
33. I feel confident about my ability to deal with computers.
34. I am (will be) proud of knowing how to use computers.
35. I am not the type of person who does well with computers.
36. I (would) enjoy having a home computer.
37. Computers make me feel helpless.
38. I feel a sense of insecurity when attempting to use a computer.
39. I feel apprehensive about using a computer.
40. Computers make me feel so stupid.
41. Computers do not scare me at all.
42. If given an opportunity, I would like to use and learn about computers.
43. I (will) avoid certain classes/jobs because of the use of computers.
44. When I hear the word "computer", I have a feeling of dislike.
45. If available, I would choose computer related work over other possibilities as my future job.
46. Computers make me feel impatient.
47. I am looking forward to the time when computers are in all homes.
48. Computers make me feel uneasy and confused.

Please move to Part III, if you never personally worked with a computer.

49. I find it difficult to keep my mind on my work while operating a computer.
50. I (would) feel calm and collected while someone observed me working with a computer.
51. I notice my heart pounding when I am asked to finish some jobs on computers.
52. I feel useless when I sit before a computer.
53. The prompt feedback from computers is somewhat exciting.
54. I perform normally while using a computer just like I usually do with other tools.
55. Once I start to work with a computer, I find it hard to stop.
56. I sweat very easily when manipulating a computer.
57. When I get into a computer problem that I cannot figure out immediately, I stick with it until I have the solution.
58. I notice I become short of breath when I am asked to do something on computers.
59. I enjoy the challenge of figuring out how a computer program works.
60. Computers make me feel as though I am lost in a jungle of "commands" and cannot find my way out.
61. Sometimes my mind goes blank, and I am unable to think clearly when working with computers.
62. I enjoy showing someone else how to use a computer.
63. I feel calm and collected even when the computer give me a lot of error messages.
64. I frequently notice my hand shakes when I attempt to work on a computer.

Use A--strongly agree
B--agree
C--uncertain
D--disagree
E--strongly disagree

Part III. Attitude toward computers

65. People would respect a person more if s/he were really handy in using computers.
66. Computer technology is creating a lot more unhappiness among people than the help it provides.
67. Computers slow down and complicate simple business operations.
68. Our country relies too much on computers.
69. Computers are valuable educational tools.
70. Even if a person does not know any computer language, s/he can still use computers.
71. Computers isolate people by preventing normal social interactions.
72. Children should be introduced to computers.
73. Everyone should be willing to give computers a try.
74. A person today cannot escape the influence of computers.
75. A computer is a tool, similar to a hammer or a calculator.
76. Our country would be better off if there were no computers.
77. In today's world, everyone should know how to use computers in some way.
78. Computers are beneficial aids to a modern society.
79. Computers have no place in the classroom.
80. I worry about the negative consequences of putting computers in schools.
81. School wide emphasis on experimenting with computers should be encouraged.
82. Computers are too complicated for the average person to use.
83. Learning about computers is a waste of time.
84. A person who has been exposed to computers will have an advantage over those who have not.

Part IV. Reasons for not using computers

85. I hesitate to use a computer for fear of making mistakes that I cannot not correct.
86. I do not like to use computers because of the typing skill required.
87. I have avoided computers because they are unfamiliar to me.
88. I do not like the idea of computers replacing human skills.
89. I hesitate to use computers because they break down so easily.
90. I do not play with computers because they are too expensive to buy.
91. I have difficulty using a computer because computers are too complicated.
92. I have avoided to use computers because the radiation may hurt me.
93. I do not like computers because they may take over my job someday.
94. I feel nervous with computers because I have to use a computer in a public place.
95. I do not like to use computers because they are impersonal.
96. I hesitate to use a computer for fear of hurting the computer in some way.
97. I do not like to use computers because I have to spend a lot of time to get familiar with computer commands and system operations first.
98. I have avoided computers because I have had some failure experiences with computers.
99. I hesitate to use a computer for fear of straining my eyes.
100. I do not like to use computers because of the mathematics requires.

Please return to:
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B3 Industrial Education Building II
Iowa State University
Ames, IA 50011

** Thank you very much for your assistance! **

APPENDIX I. FIELD TEST SAMPLES

Institution	Sent	Returned	
Ballard High School (IA)	22	22	100%
Ft. Dodge Community School (IA)	100	62	62%
St. Edmond High School (IA)	100	100	100%
Mele-Dall High School (IA)	25	25	100%
Des Moines Community College (IA) Clinical Dental Assisting (DENA 321)	18	18	100%
Marshalltown Community College (IA) Microcomputer Operations (offered to Iowa Juvenile Home) BASIC II (computer science major) Intro. to Data Processing (non-computer science major)	200	55	28%
Northland Community College (MN) Freshman English (12) Program Planning (5) Minnesota History (17)	150	58	39%
Michigan State University (MI) Introduction to Tele-communication (TC 210) Principle of Public Relations (ADV 327) Audience Survey Analysis (TC 335)	300	250	83%
North Carolina Agricultural & Technical State University (NC) Electronics	11	11	100%
University of Missouri-Columbia/Kansas City (MO) Thermodynamics (ME 099)	34	34	100%
Central Michigan University (MI) Elementary Statistics (MTH 282) Introduction to Business Mathematics (MTH 216) Introduction to Statistics (MTH 382)	282	217	77%
Iowa State University (IA) Statistics Methods for Research Workers (Stat 401) Statistics Design and the Analysis of Experiments (Stat 402) Basic Educational Research with Statistical Application (Res EV 550) Administration of Elementary Schools (Ed Adm 576)	212	143	67%

Teaching in Adult Education (Ad Ed 537)			
Educational Strategies for Secondary Vocational Home Economics Programs (H Ed 412)			
Computer Applied in Psychology (Psych 501x)			
Training Stress in Industry (Psych 650x)			
Advanced Educational Research and Design (Res EV 654)			
Industrial Education & Technology Graduate Student Club			
total	1454	999	69%

APPENDIX J. ITEM MEAN, STANDARD DEVIATION, FREQUENCY FROM JUDGES

	Item	N	Mean	S.D.	Frequency A	B	C	D	E	S.V.	D.D.
	1. I usually have been at ease during occasions when computers were involved.	49	1.76	1.07	28	11	5	4	1	0.00	0.95
-	2. I get a sinking feeling when I think that, no matter what, I have to learn/use computers.	48	4.27	1.12	2	3	4	10	29	1.95	1.18
	3. Computers are fascinating and fun.	48	1.60	1.09	33	7	4	2	2	0.00	1.37
	4. I view computers as handy tools in my life.	47	1.81	0.97	23	14	6	4	0	0.02	1.15
-	5. I probably feel more frustrated in attempting to use a computer than other people do.	47	4.06	0.87	1	1	7	23	15	1.65	0.66
-	6. I prefer to stay away from computers.	47	4.23	0.98	2	1	3	19	22	1.88	0.91
-	7. I would rather take a paper-pencil test than answer questions through a computer.	48	3.71	1.15	4	2	10	20	12	1.46	0.81
	8. I feel confident about my ability to deal with computers.	49	1.82	1.03	25	13	7	3	1	0.00	0.86
	9. I am (will be) proud of knowing how to use computers.	48	2.33	1.24	15	15	8	7	3	0.38	0.87
-	10. I am not the type of person who does well with computers.	48	3.69	1.06	2	5	9	22	10	1.43	0.69
	11. I (would) enjoy having a home computer.	49	2.29	1.44	18	18	2	3	8	0.23	1.28
-	12. Computers make me feel helpless.	49	4.47	0.87	1	0	6	10	32	1.95	0.92
-	13. I feel a sense of insecurity when attempting to use a computer.	49	4.10	1.03	1	4	5	18	21	1.79	0.80
-	14. I feel apprehensive about using a computer.	47	3.79	1.20	4	7	6	16	16	1.57	0.83

- 15. Computers make me feel so stupid.										
	48	4.23	1.21	4	1	3	12	28	1.95	1.38
16. Computers do not scare me at all.										
	48	1.77	1.04	26	12	6	3	1	0.00	0.90
17. If given an opportunity, I would like to use and learn about computers.										
	47	2.02	1.07	17	19	6	3	2	0.22	0.83
- 18. I (will) avoid certain classes/jobs because of the use of computers.										
	49	4.22	1.05	2	2	4	16	25	1.95	1.00
- 19. when I hear the word "computer", I have a feeling of dislike.										
	49	4.20	1.00	1	4	2	19	23	1.88	0.85
20. If available, I would choose computer related work over other possibilities as my future job.										
	48	1.92	1.33	31	1	7	7	2	0.00	1.18
- 21. Computers make me feel impatient.										
	47	3.68	1.09	3	4	7	24	9	1.46	0.72
22. I am looking forward to the time when computers are in all homes.										
	48	1.90	1.08	22	15	7	2	2	0.08	0.92
- 23. Computers make me feel uneasy and confused.										
	49	4.41	0.84	1	1	2	18	27	1.95	0.88
- 24. I find it difficult to keep my mind on my work while operating a computer.										
	45	3.78	0.97	1	3	12	18	11	1.43	0.62
25. I (would) feel calm and collected while someone observed me working with a computer.										
	47	1.89	1.01	21	15	6	5	0	0.11	1.16
- 26. I notice my heart pounding when I am asked to finish some jobs on computers.										
	45	4.31	0.92	0	3	5	12	25	1.95	1.19
- 27. I feel useless when I sit before a computer.										
	47	4.28	0.95	2	0	4	18	23	1.92	0.89
28. The prompt feedback from computers is somewhat exciting.										
	47	2.17	1.05	13	20	9	3	2	0.33	0.74

29. I perform normally while using a computer just like I usually do with other tools.

47	1.98	0.99	20	11	13	3	0	0.20	0.90

30. Once I start to work with a computer, I find it hard to stop.

46	1.59	1.13	33	6	2	3	2	0.00	1.55

\- 31. I sweat very easily when manipulating a computer.

45	4.18	1.21	4	0	5	11	25	1.95	1.33

32. When I get into a computer problem that I cannot figure out immediately, I stick with it until I have the solution.

46	1.93	1.16	22	13	5	4	2	0.05	0.99

\- 33. I notice I become short of breath when I am asked to do something on computers.

44	4.32	1.16	3	1	3	9	28	1.95	1.50

34. I enjoy the challenge of figuring out how a computer program works.

47	1.77	1.05	24	16	3	2	2	0.00	1.02

\- 35. Computers make me feel as though I am lost in a jungle of "commands" and cannot find my way out.

46	3.93	1.08	1	5	7	16	17	1.64	0.75

\- 36. Sometimes my mind goes blank, and I am unable to think clearly when working with computers.

46	3.98	1.16	1	5	10	8	22	1.85	0.81

37. I enjoy showing someone else how to use a computer.

47	1.72	1.02	26	14	1	6	0	0.00	1.43

38. I feel calm and collected even when the computer give me a lot of error messages.

46	1.70	1.05	28	9	5	3	1	0.00	0.99

\- 39. I frequently notice my hand shakes when I attempt to work on a computer.

46	4.39	1.00	2	1	2	13	28	1.95	1.17

40. People would respect a person more if s/he were really handy in using computers.

42	2.60	1.29	10	12	9	7	4	0.89	1.06

\- 41. Computer technology is creating a lot more unhappiness among people than the help it provides.

42	4.40	0.80	0	2	2	15	23	2.58	1.20

-	42. Computers slow down and complicate simple business operations.	43	4.30	0.77	0	2	2	20	19	2.46	0.99
-	43. Our country relies too much on computers.	43	3.84	0.97	1	4	6	22	10	2.11	0.77
	44. Computers are valuable educational tools.	43	1.79	1.01	21	15	3	3	1	0.03	1.04
	45. Even if a person does not know any computer language, s/he can still use computers.	43	1.88	0.88	15	21	5	1	1	0.30	0.84
-	46. Computers isolate people by preventing normal social interactions.	43	3.95	0.90	0	2	12	15	14	2.13	0.91
	47. Children should be introduced to computers.	43	1.98	0.83	14	17	11	1	0	0.43	0.76
	48. Everyone should be willing to give computers a try.	43	1.93	0.83	15	17	10	1	0	0.37	0.78
	49. A person today cannot escape the influence of computers.	42	2.40	0.89	9	9	22	2	0	1.07	0.75
	50. A computer is a tool, similar to a hammer or a calculator.	43	1.88	0.91	17	17	6	3	0	0.26	1.09
-	51. Our country would be better off if there were no computers.	43	4.58	0.79	1	0	2	10	30	2.58	1.25
	52. In today's world, everyone should know how to use computers in some way.	43	1.98	0.99	16	16	8	2	1	0.33	0.87
	53. Computers are beneficial aids to a modern society.	43	1.88	1.12	20	15	3	3	2	0.10	1.24
	54. Computers have no place in the classroom.	43	4.51	0.83	1	0	3	11	28	2.58	1.14
	55. I worry about the negative consequences of putting computers in schools.	43	3.93	1.12	1	6	4	16	16	2.27	0.91
	56. School wide emphasis on experimenting with computers should be encouraged.	43	2.02	1.06	14	21	3	3	2	0.35	1.01

57. Computers are too complicated for the average person to use.	43	4.09	0.89	1	2	3	23	14	2.29	0.84
58. Learning about computers is a waste of time.	41	4.44	1.00	2	0	3	9	27	2.58	1.55
59. A person who has not been exposed to computers will be at a disadvantage with those who have.	43	2.18	0.96	12	15	12	4	0	0.61	0.99

\- : negative item
S.D. : Standard Deviation
S.V. : Scale Value
D.D. : Discriminal Dispersion

APPENDIX K. THE CHARACTERISTICS OF PILOT STUDY SAMPLES

Characteristics	N	Percentage
Group		
PASCAL 175	25	21.2
ED 204 A	35	29.7
ED 204 B	37	31.4
ED 204 C,D	21	17.8
total	118	100.0
Sex		
Female	49	41.5
Male	68	57.6
Unknown	1	0.8
total	118	100.0
Age		
18	17	14.4
19	29	24.6
20	41	34.7
21	15	12.7
22-25	10	8.5
26-30	2	1.7
30-40	2	1.7
Unknown	2	1.7
total	118	100.0
Major		
Agriculture	3	2.5
Design	6	5.1
Education	59	50.0
Natural Science	15	12.7
Business	17	14.4
Language/Literature	13	11.0
Social Science	1	0.8
Behavior Science	1	0.8
Unknown	1	0.8
total	118	100.0
Computer Courses Taken		
Computer Literacy	34	28.8
Computer Programming	36	30.5
Computer Experience		
No experience	26	22.0
Use output/Play game	23	19.5

Input data/Run package	11	9.3
Program development	38	32.2
Know more than one language	20	17.0
total	118	100.0

APPENDIX L. COMPUTER ANXIETY INSTRUMENT (SHORT FORM)

Directions

This instrument is designed to provide you the opportunity to express your feeling toward computers. There are no right or wrong responses, so do not hesitate to respond the statements frankly. Please do not put your name on the instrument.

Part I. Background information

Questions in this part ask some information about you, your parents, and your school. These questions are included to relate the answers to other items in this instrument. Please answer every question.

About yourself:

Your current age in years: ______________

Your major (or intended major). For high school student, put down the course which you are most interested in: ____________________________________

The computer courses you have taken: (Please put down the total credits you took in each related area. If your credits are quarter credits, please specify.)

__ Computer literacy (introduction to computers)
__ Computer operations (keypunch operations and other peripheral equipment operations)
__ Business data processing
__ Computer applications (spread sheets, word processing, database management,...)
__ Computer applications (computer aided instruction, computer aided design/graphics, statistical analysis package, SAS, SPSSX, BMDP,...)
__ Computer programing language (BASIC, FORTRAN, PASCAL, COBOL,...)
__ Computer machine level programing/language (Assembly, C language,...)
__ Computer data structures
__ Computer operating systems
__ Computer organization and design
__ Others (____)

Your computer experience: (Select the statement(s) which most appropriately describes you. You may select more than one.)

__ I have no experience with a computer.
__ I have used a computer printout produced by someone else.
__ I have personally worked with a computer by playing computer games.
__ I have personally worked with a computer by inputting research or business information for processing.
__ I have personally constructed the program statements for running packaged programs.
__ I have personally developed a computer program.
__ I am proficient in one or more computer languages.
__ I have earned money with my knowledge of computer software or hardware.

What is your reason, if any, for not using or learning to use computers?

____

Following parts of the instrument are designed for machine scoring. Read each statement carefully, then mark down your answer in accordance with the item number on the separate COMPUTER ANSWER SHEET.

Please (1) Use a soft lead pencil.
(2) Make heavy black marks that fill the circle.
(3) Erase cleanly any answer you wish to change.

****

* Be sure to put down your ID number (which is on the right upper corner of this *
* page) on the IDENTIFICATION NUMBER columns of your computer answer sheet. *

****

1. Your current educational status:
   A. a junior high student
   B. a senior high student
   C. a 2-year community college student
   D. a 4-year college/university student
   E. a graduate student

2. Your sex:
   A. Male B. Female

3. Do you have a personal computer at home?
   A. Yes B. No

4. Do you like mathematics?
   A. Like very much B. Like C. So-so
   D. Dislike E. Definitely dislike

5. Males and females are equally capable in learning about computers.
   A. Agree B. Disagree C. Uncertain

6. Females are less likely to be encouraged to seek computer related jobs.
   A. Agree B. Disagree C. Uncertain

Item 7 through item 14 are statements which people have used to describe themselves in general. Mark the "A" (agree) if the statement is true about your. Mark the "D" (disagree) if the statement is not true about you.

7. I cannot sit in a chair for very long.
8. I feel anxious about new things or strangers.
9. I am a nervous person.
10. I feel embarrassed learning about new equipment in front of others.
11. I find it hard to keep my mind on a task or a job.
12. I feel nervous when I am being observed by anybody.
13. I do not like to face a challenge or make a decision by myself.
14. I usually find myself worrying about something.

About your parents and school:

15. Does your father's job involve computers?
    A. Directly uses B. Indirectly uses
    C. Doesn't use D. Don't know

16. What is your father's attitude toward your learning or use of computers?
    A. Strongly encourages B. Encourages C. Neutral
    D. Discourages E. Strongly discourages

17. Does your mother's job involve computers?
    A. Directly uses   B. Indirectly uses
    C. Doesn't use   D. Don't know

18. What is your mother's attitude toward your learning or use of computers?
    A. Strongly encourages   B. Encourages   C. Neutral
    D. Discourages   E. Strongly discourages

19. How does the climate of your school affect your learning or use of computers?
    A. Strongly encourages   B. Encourages   C. No influence
    D. Discourages   E. Strongly discourages

Part II. Feelings or reactions toward the learning or use of computers.

Use
A--strongly agree
B--agree
C--uncertain
D--disagree
E--strongly disagree

20. I get a sinking feeling when I think that, no matter what, I have to learn/use computers.
21. Computers are fascinating and fun.
22. I probably feel more frustrated in attempting to use a computer than other people do.
23. I prefer to stay away from computers.
24. I am (will be) proud of knowing how to use computers.
25. I am not the type of person who does well with computers.
26. Computers make me feel helpless.
27. I feel a sense of insecurity when attempting to use a computer.
28. I feel apprehensive about using a computer.
29. Computers make me feel so stupid.
30. I (will) avoid certain classes/jobs because of the use of computers.
31. When I hear the word "computer", I have a feeling of dislike.
32. If available, I would choose computer related work over other possibilities as my future job.
33. I am looking forward to the time when computers are in all homes.
34. Computers make me feel uneasy and confused.

Please move to Part III, if you never personally worked with a computer.

35. I (would) feel calm and collected while someone observed me working with a computer.
36. I notice my heart pounding when I am asked to finish some jobs on computers.
37. I feel useless when I sit before a computer.
38. I perform normally while using a computer just like I usually do with other tools.
39. Once I start to work with a computer, I find it hard to stop.
40. I sweat very easily when manipulating a computer.
41. When I get into a computer problem that I cannot figure out immediately, I stick with it until I have the solution.
42. I notice I become short of breath when I am asked to do something on computers.
43. I enjoy the challenge of figuring out how a computer program works.
44. Computers make me feel as though I am lost in a jungle of "commands" and cannot find my way out.

Use A--strongly agree
B--agree
C--uncertain
D--disagree
E--strongly disagree

45. Sometimes my mind goes blank, and I am unable to think clearly when working with computers.
46. I enjoy showing someone else how to use a computer.
47. I feel calm and collected even when the computer give me a lot of error messages.
48. I frequently notice my hand shakes when I attempt to work on a computer.

Part III. Attitude toward computers

49. Computer technology is creating a lot more unhappiness among people than the help it provides.
50. Computers slow down and complicate simple business operations.
51. Our country relies too much on computers.
52. Computers are valuable educational tools.
53. Computers isolate people by preventing normal social interactions.
54. Children should be introduced to computers.
55. Everyone should be willing to give computers a try.
56. A person today cannot escape the influence of computers.
57. In today's world, everyone should know how to use computers in some way.
58. Computers are beneficial aids to a modern society.
59. I worry about the negative consequences of putting computers in schools.
60. School-wide emphasis on experimenting with computers should be encouraged.
61. Learning about computers is a waste of time.
62. A person who has been exposed to computers will have an advantage over those who have not.

Part IV. Reasons for not using computers

63. I hesitate to use a computer for fear of making mistakes that I cannot not correct.
64. I do not like to use computers because of the typing skill required.
65. I have avoided computers because they are unfamiliar to me.
66. I do not like the idea of computers replacing human skills.
67. I hesitate to use computers because they break down so easily.
68. I have difficulty using a computer because computers are too complicated.
69. I have avoided using computers because the radiation may hurt me.
70. I do not like computers because they may take over my job someday.
71. I feel nervous with computers because I have to use a computer in a public place.
72. I do not like to use computers because they are impersonal.
73. I hesitate to use a computer for fear of hurting the computer in some way.
74. I have avoided computers because I have had some failure experiences with computers.
75. I hesitate to use a computer for fear of straining my eyes.
76. I do not like to use computers because of the mathematics requires.

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** Thank you very much for your assistance! **